INTRODUCTION TO FOREMANSHIP

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for the

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PREFACE

THE Minister of Labour and National Service, realising the need of maximum production for the war effort, and the vital contribution which foremen can make to it, has taken the constructive step of sponsoring instruction in Foremanship and Works Supervision throughout the country.

High production is not brought about by mere undirected push and drive. It depends on intelligent forethought and planning, translated into action through the medium of the foremen whose duty it is to see that production programmes are put into execution. This will not be effected by their craftsmanship and mechanical skill alone, but also by the exercise of competent managerial ability, and by an understanding of all the factors at work—including planning, progressing, organisation, labour management, and cost control. Understanding and effective use of these factors do not come by goodwill and hope, but rather by well-directed instruction on the basis of a suitable syllabus.

Not only is there an immediate and urgent problem of war production, but there is also the no less urgent, though deferred, problem of post-war production in supplying the nation's needs in the transition from war to peace economy, and in the recovery of lost markets. To this the foreman can make a vital contribution, but, as in the present emergency, he must be prepared and assisted by proper instruction to play the essential part assigned to him.

When the Minister's scheme was launched, the Institute of Industrial Administration prepared a set of Lecture Notes for the use of lecturers. The need for a text-book was urgent, and members of the Institute, competent and experienced in this field, were invited to contribute to a book designed to fill the need. The emphasis necessarily laid on the engineering aspect of war production dictated in particular the form and content of the section on Principles of Production Organisation and Planning; yet it will be found that the principles laid down throughout the book are applicable, with appropriate modifications, in other fields of industrial activity.

A section on Reading and Study has been included for the guidance of foremen students who are unable to take advantage of the instruction given in the Technical Schools.

Acknowledgment is made to Mr. G. E. Still and the Associated Equipment Company, Limited, for permission to use certain figures in Section II, and to Messrs. H. W. Broadbent, E. S. Byng, H. N. Munro, T. G. Rose, and E. Watson Smyth for much valuable co-operation.

H. McFarland Davis.

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SECTION I

GENERAL PRINCIPLES OF FOREMANSHIP AND SUPERVISION

CHAPTER I

INTRODUCTION

1. Development of Modern Industry.

History shows that industrial progress has always been stimulated by inventions and achieved by increasing and unceasing attention to details. The nineteenth century was concerned chiefly with the development of machinery from general hand tools to highly specialised machine tools. Methods of manufacture were improved by giving more attention to detail, and by replacing rough-and-ready methods by highly refined processes. Guesswork was superseded by accurate measurement.

The twentieth century has of necessity been concerned less with inventions and more with methods of organisation. Whereas in the past the greatest attention was devoted to getting more out of materials and machines, the tendency today is to concentrate on better utilisation of labour. During the past forty years more and more attention has been given to the details which will secure higher efficiency in man-power. Trades which formerly required a seven-year apprenticeship were broken down so that parts of the trade could be learned quickly by operatives who specialised in one process. At one time an engineer's apprenticeship meant an all-round training in fitting, shaping, drilling, turning, planing, and so on. Nowadays a boy perhaps starts on a drilling machine and may remain on a drilling machine for the rest of his working life.

The change has come about as the result of flow production, which is not only a condition which exists, but a process which has been going on progressively since the commencement of the Industrial Revolution at the end of the eighteenth century. It secures higher output at lower cost by setting one man to specialise in one process rather than by letting one man complete a job from beginning to end. To take an apt example—Ford made his early motor-car models himself from start to finish, but as output increased each man contributed less and less to each motor-car. The organisation of flow production was responsible for retaining expensive labour and wide experience

for the most difficult work, and for getting simple manual jobs done by cheaper and less experienced labour. In this way the process of organisation economised in the time and expense of training widely experienced engineers, and those who were already so trained were employed in the most advantageous way. Trained engineers were not employed on processes that could be done by labourers.

Industrial progress in the twentieth century, then, brought about the breaking down of processes and called for greater attention to methods of operation. In more recent years there has been a continuous drive to organise minutely every industrial process, to eliminate every unnecessary movement, and to ensure that every operation is performed in the easiest and cheapest way.

Once the necessary industrial processes had been reduced to their simplest form, it was essential to get the most effective effort from those who carried out the operations. In paying greater attention to the details which inspired human effort, numerous incentives were devised. These were mainly of two kinds: financial incentives, and non-financial incentives. The first provided a wide range of encouragements to extra effort through remuneration by results, ranging from individual piece-work to group profit-sharing. The second form of incentive concentrated on working conditions, and included the more intelligent treatment of employees, better understanding of them as individuals, and greater attention to their personal comfort.

It is essential to appreciate that although progress in industrial organisation has been constant for so long a period, it has not been uniform. There are large units and small ones; some are highly organised, and others are almost without conscious organisation; some are up to date, and others are behind the times; some are progressive and go-ahead, while others are reactionary and backward. It is not always inevitable that small, unorganised, or backward organisations will cease to exist, for they may be working on some highly profitable process or adequately protected and remunerative patent which keeps them going, or they may carry on by cheap labour, low overheads, and the incentive of personal ownership. Yet it is true that if they were better organised and more forward-looking they would have a better prospect of continued

and satisfactory development; and it is becoming more usual for the smaller concerns to emulate the methods successfully employed in larger ones, when they fully understand those methods and grasp their advantages.

The organisation of industry has been brought to its present stage of efficiency by recognition and adoption of economies resulting from flow production. It is assumed that industry is still generally conducted on competitive lines, and that the purpose of a company is to establish itself as a permanent profit-earning concern. In certain cases, however, there is a tendency for combinations to reduce or eliminate competition among their members.

To conduct business on profit-earning lines it is normally necessary to meet competition by giving better and still better value for money—generally by offering articles of one particular kind at progressively lower prices through wide publicity. Profits are maintained in these circumstances only by ever-increasing production at lower unit costs and quick turnover of this larger number of articles at a lower margin of profit on each. This is an illustration of the economy of flow-production. The whole trend of industrial development is to take the fullest possible advantage of the processes which contribute to lower costs, and these are briefly outlined below:

1. Continuity and Regularity of Similar Production.

   The unit cost of production falls with the increasing number of similar items manufactured in continuity.

2. Reduction of Intermittent Operations.

   Economy is achieved by preventing the interruptions of continuous production caused by intermittent operations.

3. Necessity for Interchangeability.

   Large-scale production demands interchangeability of parts, which in turn requires the standardisation of quality and accuracy in manufacture.

4. Simplification of Processes.

   The continuous repetition of similar processes justifies the utmost attention to the simplification of each essential detail.

5. Specialisation of Plant.

Machinery and equipment ensure the utmost economy when designed and continuously used for a special purpose.

6. Separation of Flow from Intermittent Production.

Where intermittent operations cannot be avoided these should be dealt with separately from, and not allowed to interrupt, continuous production.

7. Division of Labour.

Work processes should be sub-divided so as to allow the full specialisation of labour, according to skill employed, on the repetition of a small range of similar operations.

8. Separation of Planning from Performance.

Planning and preparation for performance should precede, and be undertaken separately from, actual manual execution.

9. Incentives to Individual Productivity.

Maximum production results from the adequate reward of employees according to individual productivity.

10. Co-ordination and Co-operation.

Utmost efficiency prevails only when there is adequate co-ordination between groups, and when co-operation exists within them.

It is to be observed that the fundamental requirements of modern flow production are :

(*a*) the largest possible continuous production of similar articles;

(*b*) increased speed, smoothness and economy of operation;

and that these are made possible by competent planning, control, and co-ordination in the organisation, which therefore tends to be of greater size and complexity.

2. Factory Administration.

Parallel with and conditioned by the development of modern industry has been the development of factory administration. There are many definitions of this term, but for the present purpose it may be considered as the conduct of the industrial undertaking. Only the briefest mention of this large field is possible here. Two of its main aspects are examined more

fully in the next two Sections; but fuller discussion of the other main aspects would be out of place in this book.

In the organisation diagrams below, and in the Section on Principles of Production Organisation and Planning, examples are given of the personnel responsible for factory administration and of the functions which they perform. It should be understood that, while these functions cover many separate activities, they have the function of administration in common. In other words, the duty of those who are responsible for the proper carrying out of these functions is rather to see that their staff perform the various tasks comprised in the work of the organisation than to do the detail work themselves. It will be seen that from this point of view the duties of the foreman also are administrative. He is an important link in the chain of administration. The higher management depend on him for the proper conduct of some of the most important work of the undertaking—that is to say, at the point of application of the principles of production organisation and planning to the work to be done on the factory floor in turning out the products which have to be marketed by the selling side of the organisation in order that it may be kept going.

The purpose of the highly involved organisation in a large factory can be most clearly understood by considering the growth of a typical company. Suppose that an engineer designs a special tool which he decides to manufacture himself. After making the first few models he finds a demand for more than he can produce by himself. So he rents a workshop and engages workmen. The engineer himself at this stage has to do all the supervision work, unaided even by a foreman, and in addition he buys the raw materials, supervises manufacture, pays wages, and despatches finished products.

He is thus discharging, unaided, the following primary functions of management :—

(*a*) Production, (*b*) Distribution, (*c*) Development, (*d*) Accounts and Finance, (*e*) Legal and Secretarial, (*f*) Direction and General Management, including Personnel Administration and Industrial Relations.

Supervision can now be illustrated in its simplest form :—

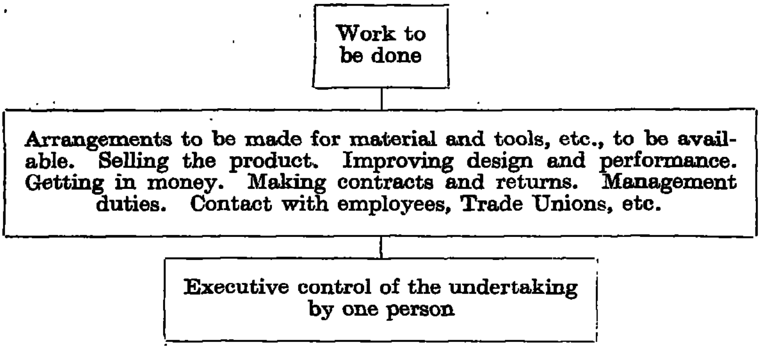


FIG. 1.

This is simple organisation of the Straight-Line Type.

The next step is

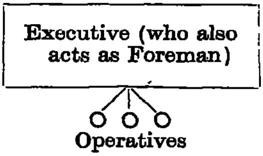


FIG. 2.

which gives the first illustration of the functions of a foreman.

If the product involves assembly of several sets of components, then this simple line of authority is expanded to suit the needs.

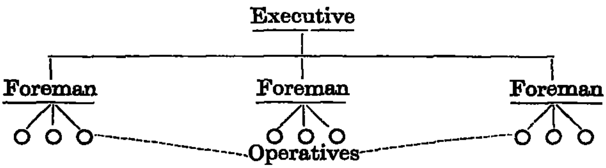


FIG. 3.

Modern development has obviously outgrown this type of organisation, even in the small firm.

Now, at this stage, he either finds an increasing demand for his product or is offered other work to do. In either case, he cannot do everything himself. He must engage a sales representative to obtain orders for his growing output. He also engages office staff to keep records of wages and costs and to deal with correspondence.

This division of labour introduces modifications in management. This is based on the idea that the main divisions of the business should be made from a scientific analysis of the work, and similar functions grouped together. It separates organisation and planning from performance.

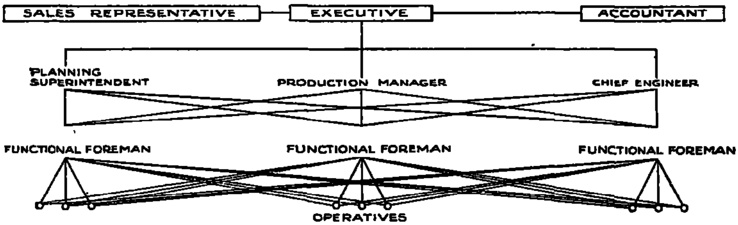


FIG. 4.

The engineer who founded the firm may now devote himself primarily to design, to the purchasing of materials and to engaging labour. Further extension brings with it many problems of new buildings, the need for more capital, increased selling activities, and so on. The engineer now assumes the function of manager and devotes his time to directing and coordinating the work of his subordinates. At this stage the private firm is turned into a company and the engineer becomes Managing Director, and devotes himself chiefly to policy. A manager is engaged to control the greatly enlarged works. Under the manager are: first, the specialists who control purchasing, labour, planning, time study, and design; and secondly, through the Works Manager, the departmental foremen. Similarly, the original sales representative becomes Sales Manager and has subordinates who are area representatives.

The organisation of the undertaking may now be illustrated in Fig. 5, p. 10.

Further growth is still possible. Two main lines of expansion exist. First, the control of smaller firms able to supply the necessary raw materials, or part-finished stores, such as patternmaking and foundry, might be purchased. This is called vertical integration. Secondly, competitors making similar products might combine for the sake of economy. This is known as horizontal combination. In both these cases the original workshop has been extended not only into a large factory, but into a group of factories, possibly making a wide variety of products.

Line and Staff Organisation

The Staff idea recognises the need for specialists who study various phases, but line indicates that authority flows from top to bottom. Little offshoots of authority in staff departments where skilled specialists are in absolute control.

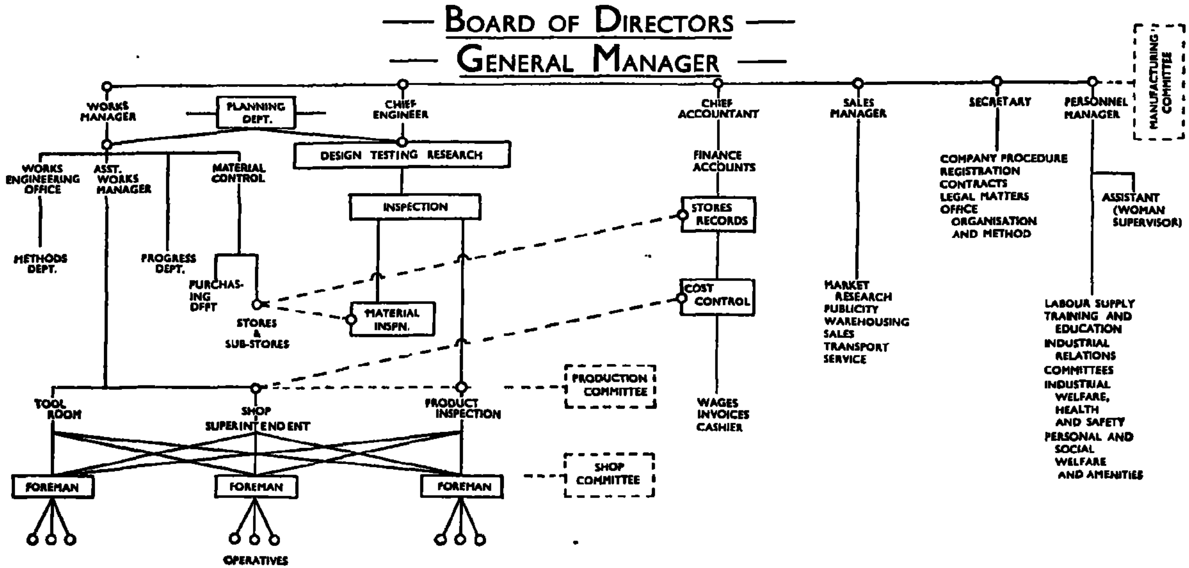


FIG. 5.

The complexity of the business is clarified through a chart such as this, which may be regarded as a general assembly of all the main functions and personnel and as showing also sub-assemblies of auxiliary functions and their personnel. It should be noted that while the general layout of organisation charts proceeds on fairly standard lines, the details of each chart have to be planned to meet the needs of the business for which it is designed.

CHAPTER II

THE FOREMAN AS ORGANISER OF WORK

1. The Foreman's Job.

INDUSTRY is in a constant state of flux. Times change. Things do not stand still; on the contrary, events today move more rapidly than ever before. New machines are constantly being introduced; methods of work are being altered and improved; and habits of workers change with adjustments in living conditions. It is consequently more difficult, but also more necessary, for the foreman to keep up to date and to appreciate that his methods must be adjusted as circumstances alter. Henry Ford divides men into two classes—plodders and pioneers—and this applies particularly to foremen. The plodders are those who are satisfied that what was good enough for their fathers is good enough for them. The pioneers are those who are go-ahead, and who want to keep up with and to improve present-day practice.

Perhaps one of the most important changes in industry concerns the duties of the foreman himself. Whereas at one time he engaged and discharged his own labour, decided which jobs should be done first, arranged which machines and methods should be used, how much should be paid, what should be accepted, obtained materials, fixed prices, and so on, this work today is done for him in the larger firms by the Employment, Planning, Purchasing, Time Study and Inspection Departments. These specialised departments help the foreman and relieve him of many details, so that he can give more time to controlling work in his department and to supervising his labour.

The foreman is no longer a jack-of-all-trades and master of none. His job is to organise his department, to produce what is required, when it is wanted, and at the lowest cost. He has become a manager of his department, where he is advised about labour, planning, piece rates, and costs, in order that he can get better results. It is not necessary for him to be a specialist in Planning, Time Study, or Employment Practice, but it is clearly necessary for him to know how these

departments work and what they can do, so as to make the best possible use of them.

Now that the foreman has been relieved of many details which formerly took a great deal of his time, he is able to concentrate on getting work done. His chief responsibilities are to see that it is done properly without undue waste of material and to get the best efforts from his men without waste of time.

These changes have brought the foreman's job into the limelight, and his importance to industry is being widely recognised. Competent general management, improved planning, wage incentives, better working conditions, and so forth are only partially effective unless the foreman can make the best use of them. If the foreman doesn't know how to use the new tools which have been given him, if he takes unkindly to progressive ideas, if he cannot move with the times, then he will be a failure as a foreman today.

It is clear that the exact nature of the foreman's job will vary considerably with circumstances, and will in general be determined by the following factors :

1. The nature of the product manufactured and the degree of technical knowledge or trade skill exercised by the foreman;
2. The extent to which routine work prevails over individual or intermittent production;
3. The proportion of skilled, as compared with unskilled, labour;
4. The degree of change, reorganisation, and state of emergency prevailing;
5. The number of employees controlled, and the size of the entire organisation;
6. The number and ability of staff assistants, such as clerks, charge-hands, section leaders, and so on;
7. The degree of assistance rendered by specialised departments, such as Employment, Planning, Inspection, Costing, etc;
8. The degree of authority assigned, and the extent of the discretion allowed to him by the management.

All these factors naturally affect the exact duties of the foreman. For instance, at one extreme the character of the work may be so highly technical, so individual, and confined to so few men, that the foreman spends most of his time on work peculiar

to his trade and product. At the other extreme the actual process may be decided and controlled by a technician such as the chief chemist or chief engineer, thus leaving the foreman to concentrate on output.

Where a very small works is concerned, it is important to set out fully the duties which are exercised by the foreman in varying degrees according to the circumstances outlined above. For convenience, these duties are arranged in three main groups—Organise work; Manage men; Develop his department.

DUTIES OF A FOREMAN.

(*Where no Planning, Progress, or Labour Department exists.*)

Organise Work.

1. Receive instructions.
2. Plan methods, machines, and men.
3. Prepare materials, tools, and equipment.
4. Arrange departmental transport of work.
5. Set standard of workmanship and inspection.
6. Control costs and prevent waste.
7. Regulate progress.

Manage Men.

1. Assign operatives to most suitable jobs.
2. Encourage employees to greater efforts.
3. Deal with disputes and complaints.
4. Ensure discipline and time keeping.
5. Maintain good working conditions.
6. Interpret company's policy.
7. Establish fair and impartial supervision.

Develop his Department.

1. Investigate interruptions and breakdowns.
2. Improve methods and flow of work.
3. Instruct and train operatives.
4. Recommend, promote, and reward competent employees.
5. Economise in working space.
6. Save time, power, and materials.
7. Secure internal co-operation and harmony.

But, as already stated, in a large and highly organised works the foreman is relieved of many of these details; and in these conditions some of the above-mentioned duties (especially

Nos. 2, 3, 4, and 5 under Organisation, and Nos. 2, 3, and 4 under Development) are modified accordingly; so that in these directions he becomes a competent adviser rather than an originating executive.

It will be noted that no mention has been made of those duties peculiar to specific trades. Foremanship is a function common to all trades, and as such does not concern itself in general with those aspects of the job which rightly belong to technical training. The study of foremanship assumes that the foreman is already a competent craftsman and a skilled technician with a sound knowledge of the theory and practice of his particular trade. The purpose of foremanship training is not to improve technical skill or impart trade knowledge, but to enable such ability to be employed to better use.

The foreman differs from rank-and-file workmen in his ability to organise work and manage men. As a workman, he knows very well how to do the job; but as a foreman he must see that others know how to do it, and that they actually produce the job. The old saying, "If you want a job done properly you must do it yourself", is nothing less than an admission of incompetent management. Although the foreman should be able to "take his coat off" like anyone else, his job is to get results from other people, not to do the manual work himself. This is the fundamental difference between the foreman and the operative. The workman can direct only his own efforts; the foreman directs the efforts of others.

The foreman's industrial responsibilities are obvious. He is surrounded by four chief interests. Firstly, he must carry out in detail the general policies and instructions issued by the management; secondly, he must help to ensure complete customer satisfaction by maintaining the quality of workmanship expected, and by honouring delivery promises; thirdly (subject to the limitations already mentioned) he must enlist, promote, train, and retain competent and contented employees; and fourthly, as far as his limited responsibility extends, he must help to ensure the permanent prosperity of his firm by full consideration of the interests of the shareholders.

It is only by preserving the interests of these four main groups that an industrial concern can be well organised and can continue to exist and progress. The interests of the community as a whole are best served when the management,

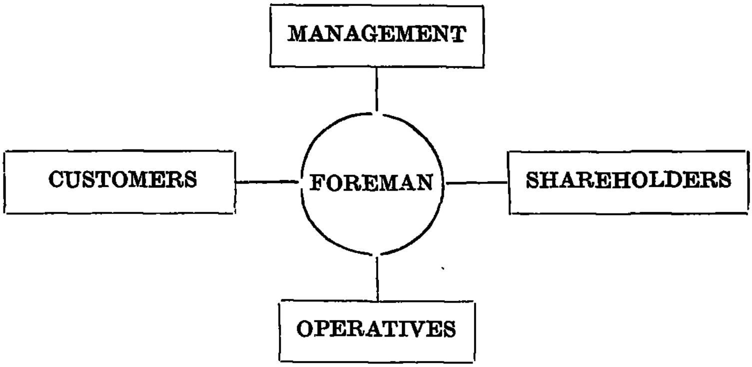


FIG. 6.

operatives, customers, and shareholders are reasonably satisfied. The foreman's central position is obvious. It now remains to consider in more detail the complicated mechanism of modern industrial organisation which surrounds him in his day-to-day work.

2. Organisation.

Simply, organisation means order as distinct from chaos. The term organisation has two uses. It describes the arrangements made for the functioning of a concern, and it explains *the process of setting up those arrangements*. Thus, in the former sense, it is common to consider the responsibilities of personnel and the routines of work established to achieve certain specified results. In the latter sense, the process of organising entails the investigation of the work to be done, deciding on the best method to be employed, planning the essential requirements in men, materials, and machines, assigning specified operatives to definite duties, and putting the whole scheme into operation. It is this process of organising which explains " why " certain arrangements are made, rather than the consideration of the final structure which shows " how " the organisation has been set up, that is of the utmost primary importance.

The process of organisation should be regarded as the servant and not the master of the persons organising. An existing organisation may have been set up for different classes of work, so that, as times change and new circumstances

prevail, fresh arrangements have to be made. Changes should be made only after complete investigation, and it is unwise to embark upon alterations without adequate preparation for every likely contingency. It should be remembered that in organising, the job comes first; and that the personnel are to be found and fitted to do the work assigned. The reverse process of finding suitable jobs for unsuitable employees is the opposite of organisation.

It is helpful to regard organisation as a process of classification, where the work to be done is arranged into convenient groups and assigned to suitable persons. In this respect, the organisation chart is useful in presenting a clear picture of the structure of a company. The chart indicates in diagrammatic form the authorities and persons conducting the firm, with their responsibilities and duties. Commonly, it is found advisable to support the chart with an organisation manual which sets out in detail the duties of every executive and lays down the routine to be followed in the execution of work. A chart is useful also in making clear the passage of orders and the routine of work from process to process. In fact, a diagrammatic chart should be used wherever possible to elucidate or explain arrangements or assignments; routines or responsibilities; divisions or duties.

Above all, it should be borne in mind that organisation is a process which sets up a mechanism to do a certain piece of work. The success or failure of that organisation is measured by the degree to which it achieves its original purpose, and the manner in which it copes with day-to-day circumstances in the execution of that purpose. Consequently, any change in either policy or circumstances warrants a review of the existing organisation to determine whether adjustments should be made or whether a comparatively new system should be devised. It should be borne in mind, too, that the personal element has a powerful influence on that success or failure. Even the best organisation can be marred, or in extreme cases wrecked, by neglect, hostility, or lack of understanding on the part of those whose duty it is to apply it.

3. Characteristics of Good Organisation.

The success or failure of a department depends on its degree of organisation. Generally, if there is an absence of muddle,

of breakdowns, and of interruptions, then the work is well organised. If all available effort is employed profitably and harmony prevails, and if there are flexibility and progress, then good organisation may be said to exist. There are ten characteristics of good organisation which the foreman should constantly bear in mind when arranging the routines of his department.

1. *Purpose.* Every process, every movement, every instruction, must have a definite purpose. The primary purpose of industry is to serve customers, so that the required articles can be produced in the quantity and of the quality demanded, and at the lowest possible cost consistent with the continued welfare of the operatives. The purpose of an organisation is contained in clear-cut instructions.

2. *Permanency.* The difference between organisation and improvisation is the difference between routine set up to continue over an extended period and instructions given to meet an emergency. Organisation depends on established routine, which deals automatically with day-to-day problems, avoiding the need for continual fresh instructions.

3. *Stability.* Good work can only be achieved when there is a substantial measure of stability with regard to instructions. Continuous changes and reversals of decisions must be avoided. The operative must know where he stands, and should not be subject to the whims and fancies of his foreman.

4. *Flexibility.* Although it is necessary for routine to be established to deal as far as possible with day-to-day requirements, and although some sense of stability must exist, it is clearly necessary that rules, regulations, and instructions must be flexible. Organisation procedure must be subject to intelligent interpretation—it should not be possible for mistakes to occur simply because instructions *must* be followed on pain of severe penalty.

5. *Balance.* Care must be taken to avoid too much attention being given to certain processes at the expense of others. It is a common feature for foremen to have pet jobs to which they devote all their time, and in consequence to neglect other processes equally important. Fairness and impartiality of supervision only exist where balance has been established.

6. *Progressiveness.* An organisation should always be such as to permit progress to be made. Suggestions and ideas for improvements should be encouraged. There should be a determination not to let an organisation become hidebound by previous decisions or too conservative in regard to future developments. The possibilities of the future must be kept constantly in mind.

7. *Planning.* It is a fundamental requirement of sound organisation that adequate preparation should precede performance. Clear instructions, the right materials, the proper tools, the correct machine, and the selected operative, should all be available at the assigned place and at the same time when performance of the work is to take place.

8. *Operating Efficiency.* There should be no loss of time or energy in the performance of work. Interruptions and breakdowns must be avoided. Unnecessary movements should be eliminated. Fatigue and monotony should be prevented. Operatives must have the incentive to devote their entire energy and attention to the job in hand.

9. *Orderliness.* Organisation can be said to exist only where order prevails. There must be a place for everything; and everything must be in its right place. Satisfactory work can proceed only where there is order.

10. *Harmony.* For satisfactory results harmony must exist. Friction prevents the harmonious progress of an efficient organisation.

* * * * *

Organisation of work involves two main processes—specialisation and co-ordination—these now being considered separately.

4. Specialisation.

Specialisation is concerned with the dividing up of the work to be done, the separation of duties, and the differentiation of functions. The work to be done is analysed and broken down into details, so that similar classes of work can be grouped together. The purpose of examining each element of work is to effect a process of separation. Preparing and planning for work are separated from its actual operation, performance, and measurement. Continuous routine and repetition work are separated from jobs requiring individual attention and

those which occur only occasionally. Piece rates are examined to separate production time from waiting time. Routine duties are separated from individual duties. Executive authority is distinguished from advisory authority.

This process of analysis, often referred to as the Exception Principle because it separates the individual or exception from the mass or routine, is necessary because it enables routine and repetition work to be handled on flow production lines. Efficient organisation is achieved by dealing with large quantities of similar work at one place at one time by the same operatives and without interruption. Individual jobs and occasional processes are handled by a separate organisation. The advantage of flow production is that it enables special systems of work to be devised; it permits special purpose machines to be employed; it allows operatives to specialise on a small range of operations; and it provides for continuous production without interruption.

Perhaps the most common example of specialisation which confronts the foreman concerns workshop operation. The choice lies between a single workman finishing the whole range of processes until the product is completed, and passing the job from one process to the next, each being operated by a different specialist. Under the first arrangement, the skilled mechanic accompanies the job to the shaping, turning, drilling, tapping, grinding, and fitting processes. Under the second arrangement, the job passes in bulk to the skilled mechanic for each process.

Another example exists in the placing of machines. Here the choice lies between grouping a number of different machines to deal with each product, and grouping a number of similar ones according to their process. With the first arrangement there might be a gear-box section or shop, next to which might be a back-axle section or shop, each section being supplied with the machines required. With the second arrangement, all products pass in bulk from the shaping machine section on to the turning shop, and thence, still in bulk, to the battery of drilling machines, and so on.

It will be seen that workshop organisation will depend on the volume of repetition work and the character and circumstances of the process. As the volume of work increases, the number of similar repetition processes also increases, so that the

possibilities of the specialisation of men and machines, and the further economy of plant and time, are always likely to occur. Specialisation means the breaking down of processes and jobs so that parts can be done more quickly and cheaply on special-purpose machines by less skilled and less expensive labour.

5. Co-ordination.

The second main process of organisation is co-ordination. This differs from specialisation in that it is concerned with the economies of combining and building up, as distinct from the economies of analysing and breaking down. It will be seen that specialisation, in dividing up processes, tends to create a large number of short-cycle operations. These can only be fully effective when brought together and co-ordinated. The process of co-ordination, therefore, consists in seeing that work passes from one stage to the next as quickly and as cheaply as possible. It must prevent interruptions and breakdowns in the continuous flow of work. It must avoid friction and misunderstanding arising between one process and the next, between one department and the next. Co-ordination means co-operation as distinct from hindrance; it signifies the difference between enthusiastic striving and disgruntled lack of interest.

The aim of co-ordination is to achieve the intelligent combination of labour and resources so as to carry on current operations efficiently, and remain sufficiently flexible to overcome any fluctuations or unforeseen obstacles which might occur in practice. Co-ordination, then, is the process of building up the numerous activities and moulding together the various efforts in the workshop in order to obtain maximum production and lowest cost by the elimination of breakdowns and misunderstandings. The most important rules always to keep in mind in the co-ordination of work are the clear, accurate statement of instructions; the precise definition of duties, authorities, and responsibilities; and the avoidance of overlapping and the omission of essential duties.

6. Rules of Organisation.

There are certain general rules of organisation which can be followed with profit, and these are :

1. Delegate duties to subordinates who should have sufficient authority to carry out their responsibilities.

2. Authority for giving instructions entails the responsibility for their complete and accurate execution.

3. Duties and responsibilities should be accurately assigned and clearly stated, and each subordinate should be entirely responsible to only one superior.

4. A superior should not control too many subordinates—a foreman ought not to supervise more than five or six charge-hands.

5. All instructions must be simple, clear, and precise; no overlapping or oversight of details should exist; written statements are to be preferred.

6. Avoidable routine and unnecessary work must be eliminated.

7. Organisation should be based firstly on the work to be done, and secondly on the persons available; the job takes preference over personalities.

8. Repetition work should be separated from individual jobs, and routine should be standardised.

9. Preparation and planning should precede, and be dealt with separately from, performance.

10. Every process must be simplified as far as possible—each man one job; each machine one process.

11. Specialisation of men, machines, equipment, process, and organisation should be facilitated to the utmost.

12. An incentive should be provided which secures maximum effort and result both from the individual and the group.

13. There should exist accurate measurement of results; and a standard of performance should be set up so that reward or rebuke can be given impartially.

14. Organisation should provide for the greatest economy in money, time, space, and energy; maximum output should be accompanied by minimum costs.

15. There should be a place for everything; everything should be in its place.

16. Facilities should exist for the treatment of complaints and criticism; and scope should be provided for the correction, adjustment, and improvement of organisation.

17. Full investigation should precede changes in organisation; major alterations should be made only after full consideration has shown them to be necessary, and then only after proper preparation.

CHAPTER III

THE FOREMAN AS MANAGER OF WORKMEN

1. Management.

NOWADAYS the foreman is part of the management; he is the manager of his own department. His department is a business within a business, and he manages it. What he needs to know is how to do this with credit to himself and satisfaction to his employers and to those for whose work he is responsible.

Where there are no separate arrangements for process planning and progress control, the first function of a foreman is to organise work. He must prepare, plan, and control its execution. In a large and well-organised undertaking the primary responsibility for and the detailed working out of these duties devolve on other officials; but the foreman will have to carry out the plan when adopted, and his advice will no doubt be sought beforehand. He will therefore take great interest in this preliminary work, even where he is not directly responsible for it.

But the setting up of an effective system of operation does not of itself get the job done. It is necessary also to engage operatives and direct their activities. Staffing, which is the second aspect of organisation, has two phases—the first, selection; the second, supervision. The selection of operatives includes the finding of suitable applicants, interviewing them, assigning them to jobs to which they are best suited. This function, in most large firms, is undertaken by an Employment Department. The progress made in the last twenty years, and the present technique involved, justify its special treatment in a subsequent section of this book.

The supervision of operatives commences when staff has been assigned to a department. While it is usually the Employment Manager's job to find the required number of new operatives, it is the foreman's job to make the best use of the men under him. He must assign to them the class of work for which their previous experience and their ability make them most suited. Introduction to the job and to other employees

with whom the new employee comes into contact is a preliminary responsibility. This must be followed by clear, adequate, and precise instructions. If necessary, sufficient training must be given to make the new employee familiar with, and competent in, his new task. Progress should be watched and encouraged, and when the new employee arrives at this stage, he begins to occupy a position similar to those already established in, and familiar with, the department.

The foreman, from his experience as a craftsman or technician, knows that good workmanship depends on the competent handling of tools, and that poor work results from not understanding what tools are capable of and how to use them. Similarly with organisation, a knowledge of the tools and how to use them produces a good job, and accordingly the management of men calls for skill and competence. Success or failure in workshop organisation depends more on this than upon systems of control.

The foreman is appointed and distinguished from rank-and-file operatives because he can organise work and manage men; and one of the main points of consideration in appointing him to organise and manage a group of subordinates is the quality and degree of personal influence he is likely to exercise.

2. The Foreman's Personal Influence.

Some sixteen years ago investigations were carried out in the mica assembly department of the Western Electric Company's Works at Hawthorne, U.S.A., with a view to obtaining increased production. The investigations lasted some time. They began with an improvement of lighting, followed by a re-arrangement of work. Rest periods were introduced and varied as to length and position in the working day. Incentives of various kinds were also tried out. In order to make the investigations without interfering with an entire department, the tests were limited to five girls, who were placed in a separate room. When the best possible results were obtained, and these were greatly in advance of the rest of the operators, the five girls were moved back into the department. The output of these girls immediately slipped back to the average of the rest. Careful investigations proved that one of the most outstanding factors in production was the influence of the foreman. Everything in the test room was a

duplicate of the original department, with the exception that the foreman had nothing to do with the test. The Company was so impressed with the discovery, that every one of its 21,000 employees was interviewed by independent investigators. The trouble and expense were amply justified, because it was proved that the foremen were not getting the best out of their operatives. Their knowledge of workpeople was inadequate, and their methods were out-of-date.

3. What Employees Want.

One of the most pressing problems of today is to attract and retain competent employees. The employer is selling employment. He must have a good reputation in the labour market. It is not what the directors *say* that counts, but what the foreman *does*. To the operatives, the foreman is the employer and represents the company's policy to the working force. When labour is scarce and the operative can choose his employment, it is naturally of vital importance that the foreman should know what the operative wants.

The most important factors which influence an employee in the choice of employers are :

1. Regularity and security of employment;
2. High standard of net wages;
3. Reasonable hours of work and travel;
4. Considerate supervision;
5. Comfortable working conditions;
6. Congenial and interesting work;
7. Acceptable work-mates;
8. Possibilities of promotion or improvement;
9. Limited personal responsibility.

Looked at from the view point of the employees, a job involves the expenditure of so much time and energy for the payment of so much wage. Although the reward of wages plays an important part in the attraction and retention of labour, wear and tear has also to be considered. The workman wants some measure of satisfaction in his work. He wants contentment.

Contentment in the workshop is the result of satisfactory working conditions. Naturally, it is affected by heat, light, noise, ventilation, dust, fumes, dirt, dampness, and so on.

Also it is affected by regularity and continuity of employment. Again, it may be influenced by promotional possibilities. Then, too, operatives appreciate provisions made for their welfare by way of canteens, pensions, sports and social clubs, first-aid, sickness benefit, and so forth.

But then, whatever the company spends on making employment attractive, employees will still leave, they will still be dissatisfied, if the human relations between them and the foreman are wrong. The employee demands modern, businesslike conduct, and a sense of organisation; he wants to be able to ventilate legitimate grievances, to receive some measure of personal recognition and satisfaction for his labour. Here, the foreman has a big part to play. If operatives leave too frequently, if abnormal absenteeism prevails, and if poor personal relationships exist in a department, then the higher management might well consider the removal of the foreman. Consequently the qualifications necessary for the exercise of modern supervisory technique are of firstrate importance, for the foreman's job is not only to get things done, but to get them done harmoniously.

4. Supervisory Leadership.

Times change, and with them social and industrial conditions. The abundance or scarcity of labour greatly affects the viewpoint of employees. The foreman and his methods cannot stand still. He must move with the times. Whereas at one time the foreman could pick and choose his staff, and hire and fire them at will, he can no longer exercise or abuse this privilege. He is no longer offering wages to unemployed men desperate for work. The boot is now on the other foot. Employment must be made attractive; the job must be sold to the employee. Apart from this change in economic circumstances, the bullying, autocratic methods of the past, whatever their temporary or even permanent effects, are certainly out of tune with conditions today. Dominating aggressiveness has given way to positive persuasiveness. In fact, what is now required is a new kind of supervisory leadership.

Leadership has three main requirements: first, a common aim; secondly, co-operation; and thirdly, incentive. The common aim in general is usually production. This is interpreted to the operative in terms of instruction. It is, there-

fore, a first condition of leadership that instructions be clearly defined, fully understood, and generally acceptable. There must be intelligent direction so that order prevails. Proper control must ensure the most effective employment of effort. No operative can give of his best if he is surrounded by muddle, waste, uncertainty, and inconsistencies.

Secondly, co-operation must be achieved if employees are to work together in harmony. This is secured not by giving way blindly to every demand the employee may make, but sympathetically receiving all complaints, criticisms, or suggestions, giving them fair consideration, and seeing that the right and proper course is taken according to the facts of the case.

Thirdly, the employee must have an incentive. This may be financial in the form of piece work or bonus reward, or may simply be commendation for good efforts or the prospect of promotion. There must be recognition of employees both as individuals and as a group. Maximum output and first-class workmanship cannot reasonably be expected from individuals who are ignored. Fair treatment in the way of encouragement for good efforts and blame for bad work are universally demanded by the operatives themselves, because in this way they are recognised and treated as individuals.

Supervisory leadership demands the full utilisation of energy. It calls for conditions of stability and permanence. The working atmosphere should combine discipline and efficiency with contentment and harmony. A constant drive for improvement should be associated with encouragement. Supervision should display impartiality with a recognition of workmen as individuals.

5. Functional and Departmental Supervision.

It has been pointed out above that at one time the foreman was the undisputed boss of his department. No one, apart from the manager, dared to interfere with the type of workmen engaged, or with the way they were treated, or to enquire why they were discharged. Methods of work, order of priority, payment of piece rates, and layout of machines were all dealt with solely by the foreman. This type of organisation is known as departmental supervision. The modification of this system was originated by an American engineer, at one time himself a

foreman, Frederick Winslow Taylor (1856–1915). It is important to recognise that most of Taylor's contribution to modern management originated from the time when he was himself a foreman. Under the old method of departmental supervision the foreman had far too much to do, with the result that nothing was done properly and there was insufficient attention to detail. Work was put in hand without preparation and there was little or no preliminary planning. Methods of working were left to the individual; cutting tools, for example, were ground according to personal likes and dislikes. Piece rates and bonuses were determined roughly and inaccurately. Methods of inspection were loose and slap-dash. Results were obtained by driving and bullying—which included a good deal of hiring and firing. In fact, supervisory incompetence seemed to be the general rule, along with haphazard methods and general ignorance as to what could or could not be achieved. The organisation of work was unscientific; the management of operatives was crude; and departmental development scarcely existed.

Taylor contended that in the workshop greater attention should be paid to details. He realised that the foreman could not decide on the method of manufacture, give instructions as to tools, materials, and machines to be used, inspect workmanship, maintain discipline, train workers, fix piece rates, calculate costs, economise in the use of materials, seek, engage, transfer, promote and discharge labour, attend to working conditions, and so forth, in any adequate way. It is obvious that the proper execution of many of these duties should be, wherever possible, the full time occupation of a specialist, who with the necessary qualifications could carry out certain specific duties not only for one department but for every department. When a company has this type of organisation it is regarded as having "functional supervision".

An example, common to many factories today, and recommended by Mr. Bevin, Minister of Labour, is the establishment of a Labour Officer or Employment Manager. Under departmental supervision, each foreman engages and discharges his own labour. This means that he has to discover likely employees either through the Labour Exchange, by advertisement, or through selection of applicants calling personally at the factory. A good deal of time has to be spent in inter-

viewing, obtaining particulars, deciding on suitability, and giving employment conditions. If he has many other pressing matters requiring his attention, then the interview is likely to be haphazard and he is inclined to engage the first person who applies for the job, irrespective of suitability. Such a method of employing labour is unsatisfactory in many ways. A foreman telephones to the Labour Exchange for a labourer. The man calls. Nobody knows the name of the foreman making the request. The man is sent away, or is engaged by another foreman, with consequent friction. Then, too, it frequently happens that a man discharged from one department for unsatisfactory work finds employment in another department of the same factory. With the centralised Employment Department, the foreman applies for his labour requirements to a functional supervisor. In this way it is frequently possible to find either temporary assistance for his department or to make a permanent transfer from another department. Full particulars are available of all employees, past and present, so that unsatisfactory workers are not re-engaged. Also, by constant contact with the sources of labour supply, misunderstandings are avoided. The highly specialised Labour Officer's wide experience in the interviewing of workers, and the fact that he has the necessary time and ability to give attention to details, are both highly important.

It may be as well to summarise briefly the advantages of departmental supervision, which is decentralised control; and functional supervision, which is centralised control.

Exclusive departmental supervision is inclined to be intensely personal. The foreman's likes and dislikes have full sway with everybody under his control, but he is able to secure rigid discipline with relative ease and simplicity. The authority and responsibility of the foreman are clearly defined; every man has only one supervisor. Under this arrangement inconsistencies between departments are likely to arise and inefficiencies within departments tend to continue without correction. The demand on the foreman is for general ability rather than for specialised ability; he is expected to undertake a wide range of duties, and consequently is unable to devote a great deal of time and attention to the details of each job.

With functional supervision in a number of departments of specialised work, such as time study and rate fixing, emphasis

is placed on the job to be done, so that relations with individual workmen are impartial and impersonal. There is uniformity of application in so far as each department is treated alike. The main difficulty with functional supervision is that it tends to generate friction. Therefore, clear-cut statement of authority and a large measure of co-operation are essential. The chief advantage, however, is that functional control enables specialists to be employed who can devote their full time to a small range of duties, and therefore go into more detail than is otherwise possible. Functional supervision is now common in regard to Planning, Design and Research, Purchasing, Storekeeping, Employment, Wages, Progress, Inspection, Costing, Accounts, and Correspondence.

It should be made clear that pure departmental or pure functional supervision rarely exists exclusively in a factory. There is a combination of both types. The modern tendency, however, is to move away from the departmental towards the functional form of organisation.

6. The Technique of Supervision.

Success or failure of supervision is determined by the aptness of the methods adopted to meet prevailing circumstances. It is not so much the *nature* of the supervisory methods, but their *suitability*, which is the deciding factor. Neither the foreman nor his methods is the first consideration; it is the existing conditions which must be understood and appreciated.

One of the main changes in industry is the growing complexity of its operation. In spite of all efforts to simplify the processes of manufacture, the increased size of workshops and factories necessitates new and complicated systems. For instance, the need for reading, understanding, and following written instructions becomes imperative, and records and entries are also frequently required of the operative. The result is that work can only be carried out satisfactorily when the foreman displays the necessary level of intelligence. Then, too, it is common for operatives to be transferred from one process to another, and this calls for both flexibility and good judgment.

Supervision today must recognise that success depends on the intelligent carrying out of clear and correct instructions. Progress is possible only where there are flexibility and initiative.

The technique of supervision covers three main tasks, namely, giving instructions, administering reproof, and awarding commendation.

When giving instructions, it is necessary to bear in mind that the person issuing the orders should know the reason for them, why they are necessary, and what they are expected to accomplish. The person receiving the orders usually knows nothing about them except what he is told. Now, to be fair to the operative, two things are necessary: first, it must be certain that he correctly understands what is wanted; and second, it must be seen to that he does not forget. More friction and misunderstanding occur in industry through incorrect, incomplete, inadequate, inconsistent, and involved instructions than from any other single cause. The foreman may know what he wants, and what he ought to say; but so often he does not say it. The foreman must be something of a teacher; he must make sure that the operative understands. Admittedly, it takes longer and requires more energy to explain slowly and carefully each process, but it saves time and money in the end. Instead of spending time arguing about mistakes for which he is largely responsible, the foreman should spend it before the job starts in making sure that misunderstanding is not likely to occur. Where possible, important instructions should be given in writing. The care necessary to give clear expression of an order will in itself prove the danger of giving instructions hurriedly and without a great deal of thought as to the actual words of the order.

The manner of giving an order is also important. Here, again, the necessity of persuading and encouraging operatives to carry out orders precisely and promptly is the first consideration. There is nothing inconsistent in discussing and explaining an instruction and in being at the same time determined to have it carried out in spite of unreasonable opposition. It is in the giving of orders that the foreman can display real supervisory technique. His job is not only to get the work done, but to get it done efficiently. The test as to whether his method is right or wrong is seen in the reaction of the operative. If the latter understands what is required, carries out the work without error, and does it willingly, then the supervisory method is correct. But if he misunderstands, makes mistakes,

finds fault, and does the work grudgingly, then the method of giving orders has been at fault.

Administering reproof is another clear example of how a foreman can raise or lower his reputation as a supervisory technician. All too frequently a reproof is made the excuse for a display of temper. The foreman gives way to his own feelings. But as a technician, his job is to point out the mistake, investigate its cause, and make such correction as will prevent the recurrence of the same or a similar mistake. It is not suggested that the same method of reproof should be applied to the hardened, careless, uninterested workman as should be given to the careful, conscientious, hardworking operative. Then, too, the punishment should fit the crime. To make a lot of fuss over a trivial matter and almost to ignore a serious offence will do a great deal of harm to general morale. After all, what distresses most workpeople is not so much the severity of a reproof but any unfairness it may contain. It is for this reason that criticism should be made with complete impartiality. Favouritism and discrimination between workpeople in a department should be avoided at all cost.

Another common error in administering reproof is to advertise the whole proceeding in front of other workmen. In particular, this error should be avoided with charge hands, section leaders and those who depend on the respect of their subordinates for such results as they can influence. Such a practice gives rise to insubordination. Finally, it should be borne in mind that the purpose of reproof is to prevent repetition of an error. It should impel those concerned to greater efforts, not discourage them from trying further. Reproof should be used as an instrument for building up efficiency based on a greater degree of intelligence and a larger measure of mutual understanding.

Perhaps one of the most outstanding drawbacks throughout British industry lies in the failure to reward commendable work. It would seem that the idea is that good work is expected and needs no acknowledgment; but that if the necessary standard is not attained, then criticism is severe. Generally there is far too much criticism and far too little praise. Commendation plays an important part in the supervisory process of encouraging operatives to make ever increasing efforts, and to achieve still higher levels of personal efficiency. Indiscriminate praise, of course, is almost as harmful

as none at all, the foreman simply loses respect, and is thought not to know the difference between good work and bad. Meritorious work should be carefully selected, and appropriate recognition given. It stands to reason that if a man tries hard to get good results, he will continue those efforts and try to improve on them if his work is duly recognised. Individual commendation provides that opportunity to encourage the better workers and stimulate a common striving toward competence and achievement.

7. Qualifications for Supervision.

Energy is the first essential of supervision. Fatigue and lassitude impair judgment and provide excuses for lack of action. As workshop organisation becomes more complicated and as working efficiency becomes more imperative, there is greater demand on the foreman's time and energy. The work of preparing and planning, the close control of performance, the need constantly to check up on progress and results, the ever-pressing demands both for improvisation and improvement, all call for large reserves of energy. It is not spurts of energy and periods of inaction that are required, but rather to sustain a high level of effort over long and irregular hours of continuous employment. The effective foreman is not one who is always in a state of excitement, rapping out random orders, and keeping his department in a state of unrest. He should be an example to his men. He must be physically fit. He must know how best to spend and how to conserve his energy. He should be prepared so to arrange his private life as not to undermine his health or interfere with his reserves of energy. While success in supervision often results from hard work over prolonged periods, it is necessary to avoid being narrow-minded, unreceptive, stodgy or dull witted. The foreman must display vitality, drive, determination, initiative, and, above all, the enthusiasm which comes from physical and mental energy, well controlled and intelligently applied, so that the effects of overwork are avoided.

A second essential of supervision is intelligence and brain-power. A foreman is expected to be more intelligent than the rank-and-file. He must be quick on the up-take, and he should be able to distinguish between the trivial and the essential; to discriminate between general issues and minor details;

and to decide between temporary shifts and permanent arrangements. He must understand and make himself understood. He must be able to think for himself; show ability to investigate; keep a sense of proportion; and be logical and reasonable. There must be a broadminded approach to industrial problems and sympathetic understanding of the human factor. Above all, he must have plenty of common sense.

Technical skill and ability are the third essential of supervision. While it is not necessary for the foreman to be the best craftsman at every process in the workshop, it is absolutely vital that he should be thoroughly acquainted with every operation, and able if necessary to show how it should be done. His technical proficiency must cover both the practical and theoretical aspects of his particular trade, as well as experience and ability in the technique of supervision. Naturally, a foreman is expected to concern himself not only with how things are done, but with why they are done, and this is what is meant by the term " technical proficiency ".

Character is a fourth essential qualification for supervision. The influence of the foreman on the productive capacity of the operatives is so important that stability, dependability, trustworthiness, and perseverance on his part are indispensable qualities. He must not abuse his privileges of rank, and must be reliable at all times and in all ways. He is expected to possess a sound sense of justice and a regard for the rights of others, and it is necessary for him to inspire confidence and promote co-operation by using tact and by showing himself adaptable in changing circumstances.

Temperament, as the fifth essential, plays an all-important part in supervision. It is the foreman's attitude towards his job, his superiors, and his subordinates, which contributes largely to his success or failure. Foremanship is a professional job, and requires that impartiality and detachment which ensure careful preparation, vigorous performance, and frank admission of results. The foreman's temperament must make for orderly progress, cheerfulness, and enthusiasm. It is necessary to be direct, frank, and positive. Temper must be even and controlled. Consideration for others and fair play must continually be in evidence.

8. How to Improve Supervision.

Managerial foremanship distinguishes those men trained, experienced and competent in supervision, who are imbued with the idea of continuous improvement both for their department and themselves, and their methods might be summarised in the following ten points:

1. Know the facts—find out all the details about what is to be done, the reasons for existing methods. Investigate procedures and practices; aim at cost reduction.
2. Recognise the essential jobs—arrange tasks in order of importance; divide what must be done from what need not be done; insist on orderliness in everything.
3. Decide on the best methods of work—eliminate waste of time and material; standardise the best practices; establish most suitable routine; remove all obstacles to progress and production.
4. Select the best man for the job—make the best use of the skill and ability available, or engage persons well fitted for the work to be done.
5. Teach and train employees—the selected workmen must be taught the best method of work and must be trained to be efficient operatives.
6. Stimulate employees—staff must be encouraged to strive for the best working arrangement, to co-operate with other employees, and to have some incentive to give their best. Recognise and give credit for good work.
7. Collaborate with the management—represent the company's policy to the operative; carry out instructions; make suggestions for departmental development.
8. Co-operate with colleagues—establish friendly relations with other departments; ensure goodwill and mutual understanding; preserve discipline, authority, and responsibility.
9. Invite suggestions—encourage initiative; consider improvements; listen to complaints; discuss changes.
10. Be fair—establish discipline without abuse of authority; control temper; reprimand justly; lead by example; accept responsibility; be clear, frank and straightforward.

Self-satisfaction is one of the most prevalent shortcomings in supervision. The longer the experience a foreman has had,

the greater is the danger of his becoming complacent. The really progressive and effective foreman is he who is constantly on the look-out for improvements in method. Such a foreman puts to himself questions similar to those listed below, and does his best to work out satisfactory solutions :—

1. Do I keep a notebook of the things to be done, and attend to them promptly and regularly ?

2. Do I know the Company's manufacturing programme and understand their methods of production organisation and planning, cost control and other operating systems, and can I explain them clearly if and when necessary ?

3. Do I understand fully the working of my own department, and that of the other departments as it affects mine ?

4. Am I spending enough of my time on the most important work ?

5. Can I delegate my simple routine duties to subordinates ?

6. Have I a competent understudy who can act in my absence, or in the event of my being promoted ?

7. What are the causes of waste, and how can they be overcome ? For example :—

> Are skilled men at high wages doing the work of manual labourers ?
> Can idle time be avoided by better planning ahead ?
> Can rejected work and defective material be reduced ?
> Are the plant and equipment in good working order ?

8. Do I know the true productive capacity of each man and each machine ?

9. Do I know individual and departmental outputs, and can I reasonably raise them ?

10. How can jigs, tools, and labour-saving devices be used to get better results ?

11. Are working conditions conducive to contentment in the workshop ?

12. Have operatives been properly trained and adequately instructed ?

13. Are employees given every encouragement to obtain optimum output ?

14. Are wages assessed fairly and paid promptly ? Do I help by seeing that all job tickets are made out correctly at the proper time, and that they reach the wages office without delay ?

15. Do I assist the work of the cost department in this way, and also by seeing that all requisitions and other cost records from my department are accurate and complete in every particular, and that the cost department get them at the earliest possible moment ? Can I reduce the number of these documents without lowering the efficiency of my department ?

16. Do I supervise fairly by giving credit where credit is due, and correct errors in such a way as to obtain improvement ?

17. Am I reducing friction and getting satisfactory teamwork in the department ?

18. Are the Company's interests always placed first and foremost, irrespective of all personal considerations ?

CHAPTER IV

THE FOREMAN AND DEVELOPMENT OF HIS DEPARTMENT

1. Investigation.

FOREMANSHIP has changed in character from getting results by bluff and bluster, to getting even better results through orderly progress. Then, too, whereas at one time it was common to get on with the job and to deal with snags as they arose, it is now necessary to foresee difficulties and to overcome them before production begins. The elaborate organisation of today does not allow for methods of trial and error, for individual idiosyncrasies, and for covering up mistakes by blaming someone else. The foreman holds a responsible position. His decisions and judgments must always be ready to stand thorough examination. Consequently, every action must be decided with care and supported with sound reasons. Satisfactory conduct of a workshop and progress in production are only assured after proper investigation.

The foreman should constantly be on the look-out for possibilities of improvement and development. He must recognise that many things done well today will be improved upon in the future. This constant urge to improve and develop must not be confused with the unstable policy of chopping and changing. In the light of his knowledge and experience of organisation and management the foreman must, however, understand what needs changing, what is worth changing, and when that change should take place.

The process of investigation starts with a review of all available facts. This frequently indicates that further data must be obtained by measurement, by experiments, or from records not already in existence. When some new method has been devised, care should be taken to ensure that every contingency can be met; and it should be made certain that after every item, every fact, every aspect has been considered, the new method will show a definite improvement over the old. The change over must be carefully planned. Those concerned should be prepared, advised, and instructed beforehand, rather

than left to find out what is happening after the change has taken place. Complaints and criticisms must be dealt with promptly as they arise, not ignored until they become serious issues. It is much better to effect improvements with active consent than to force them at the expense of discontent and misunderstanding. Persuasive preparation is to be preferred to aggressive determination. In the development of his department the foreman must first of all overcome prejudice, and time spent on securing co-operation is fully repaid at a subsequent stage in the change over.

2. **Waste Prevention.**

One of the foreman's chief contributions to the development of his department concerns cost reduction through the prevention of waste. Possibilities of improvement are unlimited. As circumstances and conditions change it is a constant struggle to keep up to date. Old methods must be reviewed periodically; poor work must be prevented and scrap reduced; space must be saved and time employed to its fullest advantage; and every interruption or cause for irritation must be removed. The foreman should constantly be on the look-out for, and rectify, leaks and losses in his department, the more important of these being listed and checked under the heading of Men, Methods, Materials, and Machines—but subject to the observations immediately following " Duties of a Foreman " on page 13.

Men

1. Provide incentive and prevent slackness;
2. Ensure economical use of labour;
3. Give clear, precise, and complete instructions;
4. Instal adequate and rapid training;
5. Avoid favouritism and personal friction;
6. Make sure that working conditions are safe and satisfactory.

Methods

1. Simplify every process and operation;
2. Plan ahead and avoid idle time;
3. Prevent breakdowns and interruptions;
4. Ensure adequate internal transport for careful and rapid hauling;
5. Instal check on proper execution of orders;
6. Maintain control by accurate records.

Materials

1. Observe and standardise inspection limits and insist on specifications;
2. Requisition adequate supplies of stores and prevent material shortages;
3. Prevent spoilt work through breakage, soiling, damage and deterioration;
4. Minimise scrap and attend to salvage;
5. Economise in use of power, heat, light and other services;
6. Provide for proper storage of materials.

Machines

1. Save space by economical layout of plant;
2. Maintain working efficiency of machines, tools, and equipment;
3. Requisition adequate supply of jigs, tools, and fixtures;
4. Attend promptly to breakdowns, and wear-and-tear;
5. Install tool racks and ensure easy operation of plant;
6. Remove redundant machinery and replace obsolete plant.

These items, each of which can contribute greatly to departmental development, do not by any means represent a full statement of possible savings, but serve to indicate the immense possibilities for improvement open to every foreman in his daily task. No department is perfect. The foreman's job is to select items according to importance and set about improving them. He must seek out sources of inefficiency and determine causes of waste as a preliminary to their extermination.

3. Self-Improvement.

As management technique improves there is need for better foremanship also. The foreman must advance with the times. His methods, outlook, and general conduct must be in accordance with his responsibilities. He is the chief factor making for success or failure in a department. Over and over again it is seen that production depends on his influence. No department can be more efficient than its foreman will allow it to be.

Training in foremanship, either within the plant or by

outside bodies, is as yet comparatively rare, and accordingly the foreman must make an effort to train himself, and must acquaint himself with new methods and new developments, and endeavour to acquire new techniques.

After all, the foreman owes his position to his ability to get results. He stands out from the rank-and-file in his capacity to benefit from experience, both his own and that of other people. He should constantly be examining the ways in which things are done; finding the causes of mistakes; and improving on old methods. Then, too, one of his chief concerns is observing how men react to instructions and to working conditions. How can he obtain better results? How can his influence be more telling? What approach should he make to this man, and that? Should he drive or persuade? Countless issues of this sort should occupy his mind.

As a man becomes experienced in his trade, so with supervision. Always the foreman has a great deal to learn, for new ideas and methods keep appearing. His ability to get results, his influence with his men, is either waning or growing. His job is constantly under review. As a tradesman he is one of many, so that while he has average ability he is reasonably secure. But as a foreman he is an individual under the direct observation of the management. If things go well, if both he and his department are up to date, he stands favourably for either promotion or salary advancement. If things go badly, if they get out of hand, if he slips up, he is subject not only to criticism but to removal.

Supervision calls for general ability, a high level of intelligence, and wide knowledge. If the foreman wants to improve his position he must progress; he must keep up to date. He must read intelligently and regularly, and take advantage of every opportunity for study, comparison, and discussion. Then, too, in order to defend himself against unfair criticism or unjust blame, he should be able to present facts, figures and arguments which will impress his superiors. Before promotion is possible he should demonstrate that he is equipped for more responsible work.

One of the deciding factors in a foreman's future is the soundness of his judgment. Promotion goes to the sound, reliable, balanced man, who not only has experience but knows how to apply it. Judgment, however, is not only a birthright:

it is acquired also from hard work in thinking out ways and means about things and persons. It is the man who is occupying himself with his many problems, constantly acquiring new knowledge, and developing his technique—in fact, the man who is mentally alive—who achieves sound judgment in day-to-day affairs.

It is well known that the man who would know others must first know himself. It is equally true that for a man to control others he must control himself. For those unaccustomed to it, the habit of self-management must be achieved before successful foremanship can be acquired. When a man has acquired sufficient self-discipline he is in a position to demonstrate his ability to effect improvements in other things, to show that he is worth training for better work, and that he is a man with a future. The man who is reasonably concerned with his future disposes of his daily work in the best attitude of mind. His outlook is progressive and constantly developing, as his department should be. He should be optimistic, encouraging, cheerful, always helpful, and continually striving towards something better.

SECTION II

PRINCIPLES OF PRODUCTION ORGANISATION AND PLANNING

CHAPTER I

INTRODUCTION

How Need for Production Organisation has Grown.

THE need for applying system to the organisation of work dates from the time when industrial processes were first conceived—viz., in the middle of the eighteenth century. Before that time the manufacture of saleable goods was governed by simple "division of labour" into specialised jobs which were carried out in the homes of the workers. This "domestic system" of manufacture applied especially in the textile industries. Naturally, so soon as men concentrated their attention on one or two simple operations, they began to find ways of overcoming drudgery and of improving the quality of the things they produced: they invented what we might now term "gadgets" to assist in these specialised operations. There was Hargreaves' spinning jenny in 1764, Arkwright's water frame in 1769, and Crompton's mule in 1779. Round about this time, too, materials began to improve. And James Watt invented the steam engine.

In 1785 Cartwright invented the first power loom: from the application of this invention in industry our present social and political history has developed. Machines became grouped round available sources of power—at first, the mill-streams; workers ceased to carry out their specialised jobs in their own homes and went to work in the mills.

As soon as people came together in this way it became necessary to organise their efforts: thus, for the first time, a certain measure of production organisation and planning became necessary. Throughout the nineteenth century we witness a development of the "factory system" of production; a history of mental and social adjustment to this important new factor in men's lives. During this period, also, there was rapid development in the quality of iron and steel and of the application of the steam engine as a motive power unit. These gave birth to the engineering industry and development of the machine tool. But the greater part of British manufacturing

output was devoted to textiles throughout the nineteenth century.

Towards the end of the nineteenth century the internal combustion engine was invented, and it soon became applied to road vehicles round about 1900. The development of the motor-car happened to coincide with a tremendous need for transportation in the United States of America. The possibilities of the motor-car were realised so fully that even the early U.S.A. models were produced in large quantities. In 1903 Oldsmobile built 4,000 one-cylinder cars all alike. From 1903 to 1905 Cadillac built 16,000 four-cylinder cars of exactly similar design. Naturally, manufacture of these early cars in such quantities involved big factories and new methods of engineering production.

It is significant that between the years of 1908 and 1927 the Ford Motor Co. produced 15,000,000 Model "T" Fords, all of which were practically identical in mechanical parts—that is, they were produced to the same drawings, from the same process, and undoubtedly, in many cases, from the same tools. The motor-car was not the only production required in vast quantities by a rapidly developing U.S.A. economy—there was the National Cash Register, the Colt revolver and Winchester repeating rifle, all of which played a smaller but not inconsiderable part in developing the need for production organisation. This rate of advance naturally caused the Americans to think intensively about methods of organising work. F. W. Taylor pioneered scientific measurement of human effort which, in its limited application, has become the basis of all systems of pre-planning production now in force—and, in its most advanced application, has developed into highly technical work-measurement systems such as Bedaux. Thus it was no wonder that between the years of 1900 and 1914 we must recognise that the U.S.A. was responsible for developing those ideas of production with which we are now concerned.

Between 1914 and 1918 the Ministry of Munitions forced industry in Britain to intensify its methods of production in order to provide in sufficient quantities the necessaries of war. British manufacturers had to abandon their policy of the "hand-made" product and copy U.S.A. production method. Probably one of the first flow production machine lines to be

laid down in the British Isles was for making the Lewis gun.

Between 1920 and 1935 the British Motor Industry developed, intensively, production organisation in Britain. Flow production machining and assembly plants were laid down to produce motor-cars of one type at the rate of 250 per day. Obviously a high degree of planning and production organisation was necessary to achieve such results. Gradually, the motor-car as we know it today was evolved, produced from high grade materials and comprising components made to such "commercial" limits of accuracy that each part should be interchangeable with an identical part. A great impetus was given to the design and manufacture of machine tools for specialised operations: British made machine tools began to supersede, to a limited extent, those of U.S.A. origin. Motor-car materials and components were required in vast quantities; new materials were developed specially to meet the needs of the new industry, such as Vibrac—a 100-ton steel for driving-shafts, and Hi-Core 90—a nickel chrome molybdenum case-hardened steel for making gears, giving a core strength of 90 tons per sq. in. Special plants had to be laid down to produce these special materials in the great quantities required.

Between 1935 and 1939 the growing aircraft industry began imposing its own special demands upon engineering production organisation, the result being a demand for new methods of production and planning to provide components to "precision" limits of accuracy from high quality materials, and in vast quantities, irrespective of price.

The last stage of this "thumb-nail" sketch of development of the need for production organisation and planning in industry is from 1939 onwards, when the Government again demands the whole of the production resources of industry and sets up "controls" to regiment production and man power. When the history of the war era is written, it will be seen what vast changes have taken place in the production field.

CHAPTER II

GENERAL PRINCIPLES

The Scope for Organising Production.

THE classification of factories according to size is illustrated by Fig. 7, which sets out figures taken from the 1936 Report of the Chief Inspector of Factories. Since 1936, of course,

CLASSIFICATION OF FACTORIES ACCORDING TO SIZE: TO ILLUSTRATE DEMAND FOR SYSTEMATIC PRODUCTION ORGANISATION.

Size group according to number of persons employed.	Factories in each group.		Group total of persons employed.	
	Number.	Per cent.	Number.	Per cent.
1– 25 . .	108,765	76·90	709,943	12·80
26– 50 . .	12,636	8·90	447,824	8·10
51– 100 . .	8,738	6·20	622,118	11·30
101– 250 . .	7,155	5·10	1,134,048	20·50
251– 500 . .	2,565	1·80	885,856	16·00
501–1,000 . .	1,016	0·70	691,204	12·50
1,001 and upwards .	519	0·40	1,039,196	18·80
All sizes .	141,394	100	5,530,189	100

FIG. 7.

there must have been some changes in these figures. Nevertheless, it is not out of order to note two rather important facts which have a bearing on the extent to which production organisation is possible in Britain. The first is the preponderance of the industrial unit with under 250 employees. The second is that in 1936 there were only 519 industrial units which employed more than 1,000 workpeople. Generally speaking, intensive systems of organisation cannot be applied economically to factories with less than 500 employees, and it is probable that our national inability to organise production on a large scale has caused the smaller factory with under 250 employees to prosper through the individual and personal

type of control which one man can exercise over such a plant. Production and planning systems in the larger production units have to take the place of this personal and individual control. Consequently, their main purpose is to weave a web of human co-operation wherein each individual becomes responsible for one clearly defined part of the total responsibility, and whereby his efforts are organised so that the result of his work and that of his colleagues follows a pre-determined policy.

2. Relation of the Production Responsibility to Other Departments.

In setting up a new organisation—or re-organising one which is badly organised—the first thing to be done is to define the exact spheres and responsibilities to be delegated to each department and official. This is a matter of high policy, but it will affect the methods of production organisation which can be applied.

Fig. 8 is a typical chart showing these responsibilities.

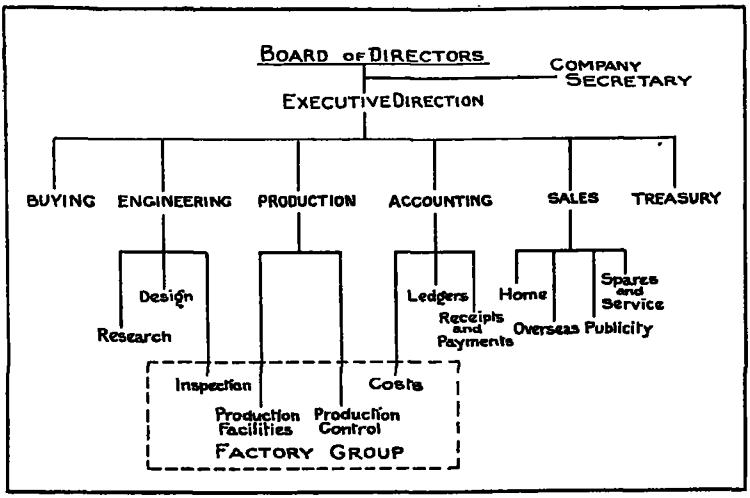


FIG. 8.

Fig. 9 is a magnification of the production responsibility,

and shows how it can be divided into specialised functions. These two diagrams are examples only. It is not possible to

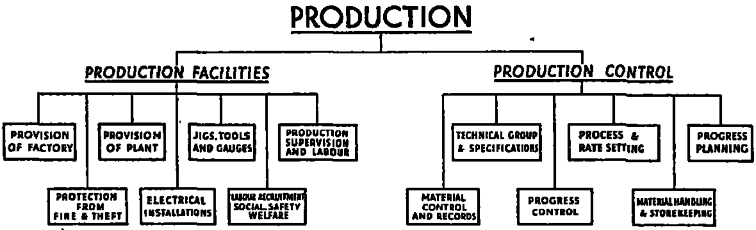


FIG. 9.

apply such divisions of responsibilities to every business—each factory must be dealt with on its own merits. The important thing to note, however, is that a clear division of responsibilities must be arrived at which can in a similar manner be set down diagrammatically.

3. Type of Production affects Methods of Organising Manufacture.

Before commencing a detailed examination of the production responsibility, it is important that some consideration be given to the broad types of production methods common to modern industry. There are three types of organisation, viz. :—

Job Production;
Batch Production; and
Flow Production.

According to which of these is appropriate to our manufacturing programme, so will the methods by which we set about pre-planning and controlling manufacture be affected. Let us, therefore, examine these three types of organisation briefly and in detail.

Job Production is still, and will always be, important in our industrial system. The phrase describes the procedure by which contracts for " one off " are handled in manufacture.

The most advanced example of job production method is in the shipbuilding industry, where each ship is built under separate contract. A considerable amount of pre-planning and organisation is obviously necessary in such a venture.

Other examples occur in civil engineering, where the building of a bridge or the construction of a water-supply scheme may be undertaken. The simplest example of job organisation is that which is involved when we send our motor-car to the local garage for a major overhaul. The same general method of handling the work applies in each case.

In the first place, the job is put out to tender—that is, the job is offered to the industry. In the case of specialised manufacture, such as shipbuilding and some types of civil engineering work, only one or two specialist firms will be asked to submit proposals for the work. On big projects it is always necessary for a great deal of design and planning to be done in order to be able to submit these proposals, and one of the first problems in job production is to decide how much time and money is to be spent in preparing the data for a contract which may be awarded to a competitor. Yet the proposals submitted to the customer must provide him with sufficient information as to the ability of the supplier to undertake the job and give satisfaction in terms both of quality and price.

When the contract is received, the preliminary plans which have had to be prepared for the quotation are then used to build up a detailed analysis of the work to be done. This is divided roughly into three parts :—

(1) A complete list of all the materials required to do the job.

(2) A complete statement showing the amount of labour required, divided into the number of hours of each type of specialised labour which will have to be employed.

(3) A detailed time sequence plan showing precisely when each kind of material must be made available, and when each type of labour is to be set to work.

The importance of such arrangements can easily be understood in the shipbuilding and civil engineering industries, where the shipbuilding yard or constructional site will rapidly become disorganised if arrangements are not made for materials to arrive in the correct time sequence—and where vast sums of money will be wasted if specialised types of labour are engaged before the time when everything is ready for them to begin their particular part of the job.

Job production methods involve :—

(*a*) A comparatively large technical sales organisation;

(*b*) A wide range of general purpose machines, tackle, and equipment;

(*c*) Large storage space;

(*d*) Accurate storekeeping to keep check on the movement and use of each item of equipment;

(*e*) A base workshop in which as many as possible of the various detailed parts required can be manufactured in their ones and twos off;

(*f*) A permanent staff of highly skilled workmen capable of undertaking manufacture of any of a wide range of different parts, each of which may present special problems in fabrication;

(*g*) Highly competent general engineers as foremen in the base workshop;

(*h*) A fluctuating demand for specialised labour at the site on which the job is to be done;

(*i*) A group of site engineers, practical men with a complete technical training, capable of taking sole charge of each contract from the aspects of costing, production, and labour management.

The success of job production method depends almost completely on the ability of the engineer in charge of each separate contract. He has to improvise a system for carrying out each job : usually he does this by delegation of responsibilities to a few trusted seconds-in-command.

Batch Production is a factory method of control, and is the most common method of organising work in the British engineering industry. It applies wherever a limited quantity of one type of product is authorised for manufacture at one time. Generally, many such quantities of different products are produced in the same factory concurrently. Examples of the batch production method occur in the medium heavy engineering industry where electric motors, switchgear, heavy motor vehicles, internal combustion engines, are produced in production runs of up to 500 off at a time. It applies equally to the light engineering industries also—especially to the sub-contract machining factories who take on the machining

of batches of components to the drawings of a larger manufacturer who has not the capacity—or specialised plant—to undertake the work himself.

Batch production methods involve :—

(a) A general purpose manufacturing plant capable of undertaking a wide range of different kinds of work;

(b) Comparatively expensive tooling arrangements in order to provide interchangeability of each part produced from the same drawing;

(c) Machines grouped together in batteries of the same type;

(d) Work passing from one battery of machines to the next in batches of economic batch size;

(e) Comparatively long production periods for making each part, due to the time that each batch has to wait before going into operation at each machine;

(f) A fairly even labour strength (under good planning);

(g) A costing system which will throw up the total cost of producing each batch of work and each batch of the finished product;

(h) A comparatively large product design and tooling design department;

(i) An efficient planning and progress control over production work to enable a continuously altering plan of work output to be applied;

(j) Large production stores areas, and generous facilities for internal transport of materials to and from each point in the production process.

The success of a batch production method of control depends almost completely upon the efficiency of the progress and production control organisation which is applied.

Flow Production methods of organising work apply only to those factories producing a mediumly complicated product at such a rate that practically all the operations have to be undertaken continuously without break. Good examples of flow production occur in the motor-car, radio, and vacuum-cleaner manufacturing industries. Flow production is usually possible where the total number of machines needed to produce

the finished article at the required rate, exceeds the number of detailed operations in completing each product. Under such conditions it is possible to arrange each production process into line sequence, so that production material " flows " from one machine to the next, and when completed is carried by conveyors to the point where it is required for assembly into the finished product.

Flow production methods involve :—

(*a*) A rigid product specification on which all development work has been carried out *before* the production drawings are released to the manufacturing unit;

(*b*) Sufficient sets of material authorised for manufacture to cover not less than the rate of production multiplied by the total time taken between authorising production and completing the finished product;

(*c*) Highly specialised machine tools and equipment laid out in line formation for the production of each major component;

(*d*) Supervision trained to a high standard of production technique;

(*e*) Unlimited expenditure on jigs, tools, and plant so long as such expenditure can be recovered within 12 to 18 months by savings in production costs which result;

(*f*) A production run on the same type of product for at least twelve months;

(*g*) A high degree of standardisation of methods, tools, and materials;

(*h*) A system of production control based upon the rate of flow of each piece of production material through the production process;

(*i*) Strict arrangements to ensure that materials arrive not faster nor slower than this specified rate;

(*j*) Panic measures to overcome any block, however slight, in the flow of production material in order to avoid stoppage in the processes not so blocked;

(*k*) Twelve to eighteen months' notice of any major change in product specification;

(*l*) Complete cessation of work while production equipment is re-arranged in sequence, to suit a new product;

(*m*) Use of conveyor systems for handling production

material from the point of completion to the assembly point.

(*n*) A daily check on production output at each key point in the production process and a seven-day inventory of materials in hand.

(*o*) Assembly operations split up into even amounts of work for each operator, based on standard cycle times.

The successful operation of a flow production organisation depends completely upon the detailed accuracy of the planning that has taken place before production commences on a new model.

CHAPTER III

DESIGN AND THE DRAWING OFFICE

It is obvious that the success of a manufacturing company depends more than anything else upon the usefulness of its product. This, in turn, depends upon two things: firstly, its design; and secondly, its cost. The first object of design is to satisfy the demand of a potential market. A secondary factor in design is to increase the "sales appeal" of the product in order to overcome competition. The success of a product from the cost point of view will depend upon the ability of the designer to provide a completely satisfactory product performance and sales appeal, together with ease of manufacture of each component part of the product. Ease of manufacture is synonymous with low cost of processing.

In developing the design of the product, the designer must make use of all available knowledge of the performance of materials and mechanisms which is at his disposal. In recent years he has been helped considerably by systems of co-operative and national research. Examples of this are found in the automobile industry, where a research laboratory financed by motor manufacturers has been set up to investigate design and material problems for the benefit of the motor industry at large; while on a bigger scale is the work of the National Physical Laboratory, which is financed by the State to supply information which will improve the performance of products important to the national economy. If the product is of a highly specialised type, however, it may be necessary for the manufacturing organisation to have its own experimental department; this is especially the case if there is intense competition between different manufacturing units: then the work of the experimental department becomes highly secretive. From the production point of view, however, technical development of the product is important, insofar as the design must be completed before it is released for production. Thus it is a first principle of pre-planned production that an experimentally

made product should be subjected to all possible performance tests in order completely to satisfy the sales department before production actually commences.

Having designed the product, produced an experimental model, and noted those adjustments to design found necessary after experimental tests, it is then the function of the drawing office to prepare all the information required for the production of each component part. This is done by preparing, for each piece, a separate production drawing. The drawing must denote all the dimensions to which the part is to be produced, and the dimensions must be in one system of measurement. Standard systems of tolerances must be set up and clearly denoted on the drawing with standard nomenclature. Standard material specification symbols must be adopted, and the quantity of material necessary to produce one part to the dimensions shown on the drawing clearly stated. The drawing must also indicate precisely when special kinds of finish, such as grinding, polishing, or lapping, are necessary. Most important of all, the drawing must have a number.

It is of very great assistance to production if the numbers allotted to drawings follow a plan which will ensure that all parts of the same type fall into the same series of numbers. Under this system it is possible for the drawing number to be the part number of the component; and all references to it in the buying, production, and costing systems can then be kept under part number records. In deciding the process for a new part, or the jigs and tools required, the adoption of standard processes, the use of standard tools, and the use of already existing equipment, are greatly facilitated if it is possible quickly to produce the records of production of all similar parts which have been made previously: a series system of allotting part numbers enables this to be done.

Having made all the production drawings, it now becomes necessary for the drawing office to prepare complete specifications or parts lists showing the part number of each component, its correct description, and the quantity used in one complete product. Parts lists should be written in assembly sequence order, so that an examination of the list will show how the parts are assembled together. Carefully compiled lists will avoid the necessity of issuing assembly drawings to show the fitting shops how the product is put together (see Fig. 10, p. 56).

PARTS LIST.

Nº OF SHEETS 1
SHEET Nº 1

UNIT *ENGINE* UNIT Nº *A 187*

SUB-ASSEMBLY *PISTON & CONN. ROD.* COMPLETE Nº *A1/0212*

PART Nº	DESCRIPTION	QTY.	REMARKS
A3/11583	PISTON	1	
A11745	GUDGEON PIN	1	COMPLETE Nº FOR
99-212	" " CIRCLIP	2	SPARES REQUIREMENTS
A3/11608	PISTON RING-SCRAPER	1	= A2/5562
A 2/11697	" " – COMPRESSION	3	
A 11942	CONNECTING ROD	1	
A44416	" " SMALL END BUSH	1	
Z44093	" " BEARING DOWEL	4	
A 12146	" " BEARING SHELL	2	COMPLETE Nº FOR
A 12245	" " " SHIM	2	SPARES REQUIREMENTS
A 12315	" " CLAMP BOLT	2	= A 1/5615
A54606	" " " " NUT	2	
100-12	" " " " SP. PIN	2	

EXAMPLES OF PART NUMBER SYSTEM:–

PISTON SERIES	= A 115 --
PISTON RING SERIES	= A 116 --
GUDGEON PIN SERIES	= A 117 --
CONNECTING ROD SERIES	= A 119 --

ETC. ETC.

FIG. 10.

It should be observed that the parts lists will be issued in the manufacturing system for the following purposes :—

(*a*) To requisition all the material required for production;

(*b*) To enable production planning engineers to build up the total requirements of plant, tools, etc., to enable the production programme to be carried out;

(*c*) To show the finished parts store what material must be issued to assembly departments for the final assembly programme;

(*d*) To show assembly departments what material they must receive from stores and how it is to be put together;

(*e*) To enable the inspection department to ensure that the assembly shops have used the correct materials;

(*f*) To enable the factory costing department to build up the total cost of producing the product.

CHAPTER IV

PRODUCTION FACILITIES

HAVING seen that job methods of production depend for their successful operation upon the personal control of a specialist in charge of each job, and having realised that flow production methods can be applied only in the exceptional case where large quantities of a mediumly complicated product are required, it will not be inappropriate to use the industrial unit operating a batch production system as an example upon which to build our conception of the methods of systematic organisation which it is our purpose to understand.

First we must build a factory, equip it with machine tools, design and manufacture jigs and tools, apply labour to the machines, supply supervision to control the labour, institute systems of inspection and costing. We must also make provision for keeping the factory buildings in good order, maintain the machine tools in a proper state of efficiency, and keep our workmen and supervision happy and willing to do the task set. In other words, we must provide all those facilities to enable production to be carried out, shown on the left-hand side of Fig. 9, p. 48.

1. Selection and Layout of Site and Plant.

If we are setting up a new factory, a great deal of careful consideration will have to be given to the selection of a site. Some of the factors which have to be taken care of are as follows :—

(*a*) Is the area available sufficient ?

(*b*) Is there room for expansion should this be necessary at a later date ?

(*c*) Is the shape of the area suitable ?

(*d*) Is suitable labour available locally ?

(*e*) Is the location accessible for either :

raw material supply,

or

the market for the finished product ?

(*f*) Is rail or water available for transport?

(*g*) Is power available, or has it to be generated?

(*h*) What is the cost of rates?

(*i*) What is the cost of the land?

(*j*) Is the subsoil suitable for carrying the weight of the buildings proposed?

(*k*) Are means for drainage readily accessible?

(*l*) Has the location any publicity value?

(*m*) Are there any legal restrictions on the use of the ground—such as rights of way, etc.?

But more important and more directly linked with the actual job of production, will be the specifying and selection of the required plant and the arrangement of it within the factory premises. Here it is obvious that a great deal of pre-planning must be done.

Each individual component of the product must be examined in detail and the number of minutes' work on each type of machine tool noted. Having collected this information for each part in the product, it is necessary to arrive at a total number of hours of each type of machine work involved in producing "one off" of the product. This information, when multiplied by the rate of production desired, should give a close indication of the number of each type of machine tool which is necessary.

In allocating the operations to different machine types, it will also be necessary to keep a careful note of the size and performance required of each individual machine. These data must be used in selecting the appropriate machines to be purchased from the products of the various machine tool manufacturers. Wherever possible, machine tools of the same manufacture should be employed, in order to standardise accessories, replacements, overhauls, and work standards.

The arrangement of the machine tools and other production equipment within the factory building areas requires the most careful consideration—decisions on general policy in this respect are best when arrived at by a sub-committee of officials representing the interests of:—

Factory engineering;	Production planning;
Process and rate setting;	Shop supervision.

In flow production plants the machine tool layout must be very flexible—capable of rapid alteration to suit new products : the correct disposition of each item of equipment can save bottlenecks in production and consequent accumulations of material which represent direct financial loss. In batch production plants, where the machines are for the most part grouped in battery formation, similar attention should be given to this point : the correct disposition of plant can reduce inter-department transport problems and facilitate that general directional flow of material which must be attempted even under batch production conditions. Modern individual motor drive machine tools reduce the problem of plant arrangement : the cost of moving a machine from one location to another is now so small that it is inexcusable not to attempt to arrive at a planned plant layout. The difficulties which often arise, however, so resemble chess problems that it is of great assistance to have a plan of the factory area laid out to a scale not smaller than $\frac{1}{8}$ inch to the foot, on which two dimensional cardboard models of the machines—showing overall movement of cross-slides, maximum swing of boring bars in turrets, etc.—can be placed to indicate proposed arrangements before movement of plant is authorised. By this means it is possible to see, in advance, if the plant will go in the space available, and it becomes possible to set up standards for space round machines, for floor inspection areas, for gangways, etc., and also to ensure that each change in plant layout is consistent with some general plan of expansion or contraction according to the dictates of production policy. This is very important : well organised establishments endeavour to plan development of the factory site for periods up to five years ahead.

Similar methods need to be adopted to plan availability of production services, such as heating, lighting, power, gas, water, sprinkler, and compressed air mains. Just as every ship carries an up-to-date plan of all such supply lines, so should the factory engineer keep records of all installations and alterations he makes thereto. It is elementary to state the need for easy identification of each of these service lines to avoid tragic accidents : the simplest method is a colour code, and to arrange for all installations in connection with one service to be painted conspicuously in one colour throughout the factory.

Not the least important part of factory engineering is con-

cerned with maintaining the efficiency of production equipment. Obviously, the first thing to be done is to encourage machine operators and production supervisors to take care of the machines they are using. Unfortunately this must conflict to some extent with demands for production: it is obvious that workers cannot take an interest in keeping machines clean and in good order unless time is allowed for them to do so. The usual compromise is to allow up to ½ hour per week for "cleaning and oiling up". Day-to-day breakdowns must be most promptly dealt with: it will be found to save money to have millwrights standing by on each group of 100 machine tools, ready to reduce stoppages which may result from breakdowns. The most important action to be taken to maintain plant efficiency, however, is to plan for periodic overhaul of each item of production equipment. With modern machine tools, overhaul programmes can be based on a five-year cycle, but at each overhaul the machine must be completely stripped down and *all* worn parts made good. The cost of each overhaul can be as high as £200, for a tool costing £1,000 new, so long as the equipment is put back into production in a condition which results in a performance equivalent to a new tool.

In order to earn the maximum possible revenue from the expensive machine tool, it is obviously necessary that it be kept producing continuously. In flow production plants this is easily done, because the location of a machine tool in production line sequence automatically results in its use to the extent decided when the layout was planned. Under batch production conditions, however, it may be difficult for those in charge of production to check that the machine tool equipment is being used by supervision to the maximum extent. A common method of overcoming this is to take a periodic analysis of "idle machine hours" against total hours worked from the works costing department's records. Energetic measures to overcome inefficiencies revealed by such an analysis are essential to reduce manufacturing costs and to ensure that pre-determined outputs can be achieved from the equipment provided.

2. Provision of Jigs, Tools, and other Special Production Equipment.

There are two reasons why jigs and tools are applied to quantity production :—

(1) Primarily jigs and fixtures are necessary to give the product the essential quality of interchangeability—that is, any part produced from one drawing must be identical with another part made to the same drawing insofar as it can replace that part without any form of fitting or adjustment. In other words, the use of jigs, tools, and fixtures is to increase the accuracy of manufacture. With few exceptions, mass produced parts must always be produced more accurately than hand made parts.

(2) In practice, however, the use of jigs and tools has also been found to lower manufacturing costs by reducing comparatively complicated—and what have been considered highly skilled—operations to a simplicity which enables semi-skilled or even unskilled labour to do them satisfactorily.

It may be taken as a rule that in order to produce components to the standards required by modern design, the assistance of jigs and tools is a positive essential. Thus, even though a comparatively small quantity of a product may be required, it is necessary to provide special tools and production equipment to enable the required degree of interchangeability to be achieved. Not infrequently on short runs of a product—possibly the initial batch intended to "test" the market—the cost of the special tools required, even though to a large extent they may be improvised, will exceed the total costs of production.

When improved tooling will reduce the cost of manufacture, it is obviously necessary to consider whether the cost of the new equipment will balance the saving. This depends upon the total number of a part which it is estimated will be made. Thus on parts in continual demand—especially under flow production conditions—ambitious tooling schemes become practicable. Taking a simple example, assume that under certain conditions a part costs 1*s.* 3*d.* to produce; that by introducing tooling improvement *a* the cost can be reduced to 1*s.* 2½*d.*; that by introducing tooling improvement *b* the cost can be reduced to 1*s.* If improvement *a* will cost £10—*i.e.*, 2,400 pence—a total of 4,800 parts must be produced to make the improvement worth while. And if improvement *b* will cost £100—*i.e.*, 24,000 pence—a total of 8,000 pieces will have to be produced before the economy becomes apparent. It can

be seen, therefore, that accurate estimating of tooling costs is a primary part of jig and tool work.

The jig and tool department will receive its detailed requests for provision of tools from the process and rate setting department. This information is usually conveyed by a copy of each process layout, against the operations on which will have been marked the type of tools which will have to be provided. The jig and tool department must then specify existing tools which can be used or adapted—or design, and have manufactured, new equipment. Here again the procedure will be simplified under a planned part numbering system, where all components of similar design carry the same part number series. A tool numbering system must be introduced —a common practice being to use the part number of the component for which the tool has been designed, with suffixes indicating the operation number and the number of tools for the operation.

Thus for part number P.12345, tools for first operation can be designated :—

Chuck jaws	P.12345–1A
Form tool	P.12345–1B
Form tool	P.12345–1C
Special drill	P.12345–1D
Special reamer	P.12345–1E

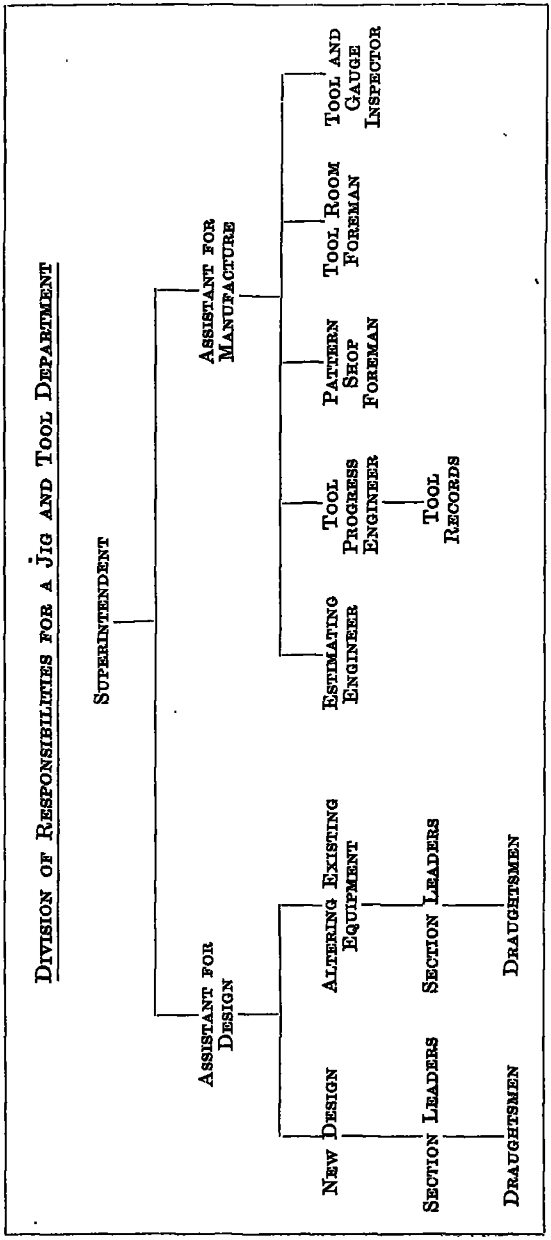
and for operation 2 :—

Milling fixture	P.12345–2A
Special milling cutters . .	P.12345–2B—2 off.
Etc.	

A great deal of co-operation will be necessary between jig and tool department and design, process engineers, and factory engineer, in order that design, processes, and plant may be altered, if necessary, to reduce tooling costs or to make general improvements in manufacture through tooling. In some factories steps are taken to ensure this co-operation by holding a periodic conference of the following interests :—

Jig and tool design ; Product drawing office ;
Process and rate setting ; Factory engineering ;
Production supervision,

to discuss improved manufacturing methods.



Division of Responsibilities for a Jig and Tool Department

Fig. 11.

Jig and tool records must be arranged to show :—

(1) For each production component, the tools to be used for its manufacture.

(2) For each tool, the production components which require its use.

(3) The history of each tool and its sub-store location.

Division of responsibilities for a jig and tool department are shown in Fig. 11, p. 64.

Tool room.—The manufacture of the required jigs, fixtures, and tools, etc., necessary for production is the task of the tool room. In recent years there has been such a heavy demand for new production equipment that tool room facilities in most organisations have been considerably over taxed. Consequently there have arisen many separate tool making organisations which specialise in the manufacture of such equipment for production factories. Thus there is a tendency for the tool room of the production factory to become responsible only for maintaining in good order the production equipment which has originally been provided. It remains true, however, that the tool room must be capable of undertaking the manufacture of any piece of mechanism on a " one-off " basis to a high degree of accuracy. Thus it must be staffed by the most highly skilled machinists and fitters available. Consequently tool room workers are, in many cases, taken on to the permanent staff of a company and paid on a time work basis.

It is clear that the tool room plant must be of a highly adaptable type, and that general purpose machine tools are necessary, having a wide range of adaptability combined with extreme accuracy.

Since the tool room is responsible for providing jigs, tools, and fixtures which will govern the accuracy with which the product can be manufactured, it follows that the tool room is the source of accuracy for the whole of the manufacturing departments. Special measures have to be taken to maintain an accepted standard of measurement throughout the whole of one producing unit and, further, in recent years, due to the inter-working between industries through sub-contracting, it has become necessary that the same standards of measurement should be accepted within specified degrees of accuracy throughout the engineering industry.

Accuracy of measurement is conveyed, both nationally and within the factory, by the use of standard reference gauges. These were introduced and originally manufactured by C. E. Johansson of Sweden about 40 years ago, but in recent years British gauge makers have produced similar reference gauges, their plant being of such a high degree of accuracy that they are authorised by the National Physical Laboratory at Teddington to issue N.P.L. certificates for all the gauges that they produce. These standard reference gauges take the form of rectangular blocks of special quality steel of extreme hardness, having two opposite faces lapped flat and parallel in terms of millionths of an inch, so that a series may be "wrung" together to produce any definite size quickly. The gauge blocks are made in strict accordance with the National Physical Laboratory requirements, and are guaranteed to fall within specified limits at a standard temperature of 68° Fahrenheit.

Under war-time conditions there are two types of reference gauges generally available, the accuracy of which is indicated in the following table.

Size of gauge.	Maximum permissible errors in length (unit = 1 millionth of an inch).	
	Workshop A grade.	Workshop B grade.
Up to and including 1 in. (25 mm.) . . .	+15 − 5	+25 − 5
2 in. (50 mm.) . . .	+20 −10	+30 −10
3 in. (75 mm.) . . .	+30 −15	+40 −15
4 in. (100 mm.) . .	+40 −20	+50 −20

Before the war, reference gauges in general availability were produced to even greater degrees of accuracy than the "Workshop A Grade" type, the standard "calibration" type gauges being accurate within 5 millionths of an inch below 1 in. and 5 millionths of an inch per 1 in. of length for all sizes over 1 in. For normal production purposes, however, where the "awareness" of measurement is not expected to be closer than

1/50,000 of an inch, it is obvious that gauges which are made to within 2 millionths of an inch are quite inappropriate, and that the war-time "Workshop Grade A" and "Grade B" references are excellent standards to which to work.

The procedure for maintaining the accuracy of reference gauges within the production unit is to have a master set which is not used except in cases of dispute, and to replace this at periodic intervals of 6–12 months. When replaced, the master gauges are then passed on as a sub-standard set to come into daily use as direct reference gauges by which the accuracy of all tools and workshop gauges may be checked. It should be noted, however, that gauges at the sub-standard stage are only used under a comparator, and not in direct contact with the gauges or tools being checked. A sub-standard set of gauges will be required for daily use in the tool room, and a second set will be needed by the inspection department. When the sub-standard gauges are, in their turn, replaced, they may then be used for direct measurement in contact with the tools being checked. They are at this stage, therefore, allotted to the tool and gauge manufacturing department.

Sets of reference gauges are fairly expensive; a standard set of the best gauges costs in the region of £50. It follows, therefore, that in small organisations it may be possible to have only one set of gauges to which all references must be made. It is possible in such cases to save the cost of replacement by having the gauges re-checked at intervals by the National Physical Laboratory or an N.P.L. approved gauge-maker.

3. Inspection (Technical Control of Product).

It is the responsibility of the inspection department to control the manufacture of the product from the quality point of view—to ensure that the parts produced are strictly to the specifications and dimensions necessary for satisfactory product performance.

There seem to be no clear conventions as to the position of the inspection department in the organisation of a manufacturing unit. In some cases the chief inspector reports to the works manager, in others to the sales department, and yet again in other instances to the chief engineer. There is a special argument in favour of the last-mentioned arrangement, insofar

as the chief engineer, being responsible for the design of the product, is also given ultimate responsibility for checking that the product produced is to his requirements. When the inspection department reports to the sales department, or is part of the factory group of responsibilities, there is a tendency for it to set up arbitrary standards of its own which may have no direct link with product performance. It is clear that the job of the organiser in dealing with the inspection department is very difficult, since if the department is too strong, practically no work at all will be passed, whereas if it is weak, there will be continuous trouble through a defective product. As in most difficult problems, a middle way must be followed. Thus, here we must suggest that the matter of inspection responsibility is one for discussion in relation to the particular type of organisation and product with which we have to deal.

It can be taken as a general rule that a bad inspection department is one which will not pass any work which is not strictly to drawing. A good inspection department is one which knows how far the drawing may be departed from without interfering with the successful operation of the product.

There are four divisions of inspection :—

(1) Physical inspection of goods purchased.
(2) Chemical analysis of materials supplied.
(3) Floor inspection of components produced.
(4) Final testing of finished product.

The inspection department must have its own sub-standard set of reference gauges issued and kept accurate by the jig and tool department, to constitute the controlling reference of accuracy for the inspection department. As in the case of the master set of reference gauges held by the jig and tool department, the inspection reference blocks should only be used under a comparator : thus it will be necessary to have a second set of inspection reference blocks which may be used for direct measurement check of the inspection micrometers and gauges used for floor inspection.

The inspection department should be decentralised, and floor inspectors allotted to each process of manufacture. The amount of inspection to be done obviously depends upon the accuracy of manufacture required, and the ability of the

productive labour employed. Thus with unskilled productive labour a fairly big inspection department may be needed to maintain accuracy to loose commercial standards, whereas precision manufacture may be controlled by a comparatively weak inspection department, providing productive labour is highly skilled and earns good remuneration for the work correctly done.

Where manufactured products are complicated, involving a long series of processing operations, it is important that the amount of inspection should be increased in order to avoid a great deal of work being done on material which should have been rejected at the early operations.

Inspection on quality production is a highly skilled matter; its success depends almost completely upon the skill of the chief inspector in arranging details of inspection for each phase of the manufacturing process, and deciding at each point the proportion of parts to be inspected.

Under strict systems of work output control, such as tight piece work systems, or under arrangements similar to those appropriate to the Bedaux system, much more inspection becomes necessary, and the checking of detailed operations is sometimes split into specialised operations which can be carried out by semi-skilled or unskilled personnel.

A commercial system of inspection would control quality at the following points :—

(*a*) At the goods receiving point, to ensure that the materials supplied are to specification;

(*b*) Inspection of one sample before any manufacturing operation is allowed to proceed;

(*c*) Percentage inspection of work upon the completion of all the operations performed by one department, in order that defective work shall not be passed out to another department;

(*d*) Final inspection before finished components are passed to stores or assembly;

(*e*) Unit assembly inspection;

(*f*) Final product inspection.

For finished product inspection the tests to be applied depend upon the nature of the product. It is important,

however, that certain principles be followed, the most important of which is that product tests should as nearly as possible reproduce service conditions, accentuated to a known degree. Thus, if the product is an internal combustion engine which in service will be required to stand up to full load conditions for periods not exceeding 30–40 minutes, we should expect that the final engine test will be such that full load conditions will be applied for at least four times this period. In such a case the factor of safety of the test will clearly be 4 to 1.

The success in operation of an inspection system obviously depends upon eliminating service failures of the product and customers' complaints. Thus it is important that the inspection department should be informed of all failures dealt with by the service department, especially every case where free replacement parts are requested under guarantee. Each such case must be investigated to ascertain precisely why replacements are necessary, whether it be due to defective design, materials, or workmanship, and energetic steps taken to ensure that such faults do not recur.

The inspection of materials becomes of major importance in complicated engineering products, where the performance of the product is high in relation to the total weight of materials used—*i.e.*, where design attempts to cut down the size of components in order to reduce weight. In most cases inspection of materials is a simple metallurgical process which costs very little to operate. Therefore it is generally worth while to make provision for metallurgical inspection within the plant. If, however, it is decided that this is not warranted, it will become necessary to use the services of a materials inspection consultant, who can make tests on behalf of the organisation. It is an elementary point, however, that where high quality materials are being purchased, it is important always to check that the materials are to specification.

The inspection department must be responsible for passing of work to finished parts store or assembly, and the usual procedure is to arrange for the final inspector to make out a material movement document certifying that a certain number of parts off a specified works order have been completed and are satisfactory for use. In addition, each inspector should make out an inspection report showing precisely what batches of work he has inspected each day and the number of parts he has

rejected or scrapped. Copies of each inspection report should be passed to the :—

(*a*) Works manager;
(*b*) Production control department;
(*c*) Production supervision;
(*d*) Works cost office.

Parts which are scrapped by the inspection department must be mutilated in such a way that there is no possibility of their being used, but before this is done they should be surveyed by production supervision, chief inspector, and production control interests, in consultation, in order to decide finally that salvaging either is impossible or is not worth while.

CHAPTER V

PRODUCTION PLANNING AND CONTROL

HAVING arranged for preparation of a complete specification of the product, and provided the facilities whereby production is to be carried out, it now becomes necessary to consider the procedure to be set up for planning and controlling manufacture, and to arrange that production materials be supplied to the factory in step with such plans as are made. It is at this point, therefore, that consideration must be given to the responsibilities set down under the Production Control function on Fig. 9.

It is clear that if an exhaustive study of methods of organising work were made, it would be necessary to examine how it is to be done in each different manufacturing industry—and each size of factory within such indutry. Such a study of the subject would compete with the *Encyclopaedia Britannica* for size. In these notes reasonable brevity is essential. While these pages are concerned with principles rather than method—principles which apply equally to factories of different sizes and manufacturing different products—it is recognised that a mere recitation of principles leaves the practical man with the feeling that many of the things said are too idealistic ever to be possible in practice. It is necessary, therefore, to show how principles can be applied; and obviously the best way of doing this is to select some particular type of organisation about which can be built up a practical system of control.

War-time experience has, so far, tended to prove that it is especially the factory with 500 or more employees that is the " problem child " of the production war-effort, and that is causing supply " bottle-necks " through lack of systematic manufacturing controls, though these defects exist in many smaller concerns also. It is with this size of factory that one-man control breaks down and must be supplanted by delegation of specialised responsibilities : it is especially within this and larger types of organisation that new men are required to accept the specialised supervisory and administrative re-

sponsibilities which must be delegated by those in supreme command; it is within an organisation of such size that the application of principles can be studied as departmental actions. In the notes that follow, therefore, an engineering factory with 500 or more employees will be taken as the example upon which to demonstrate how these principles can be applied. And so that the treatment may be comprehensive, it will be assumed that the factory is one where production conditions are difficult.

It is usually found that engineering production is the most difficult type of manufacturing work to control, and that this is especially the case where the product is itself a complicated piece of engineering with a hundred or more different parts which have to be manufactured in batches. If some of the parts have a large number of manufacturing operations to be done on them before they are finished, they will take a long time to produce: complicated production processes become necessary, coupled with accurate production planning. If, in addition to these factors, there are several different models of the product in production at the same time, and the precise ratio of output for each cannot be determined more than two or three months ahead, it will be found that the people who are responsible for production are presented with the most difficult of production problems.

The documents and charts used to illustrate this section, and the descriptions of their use, are intended to deal with a factory having all these complications, so that the reader may understand how principles of production planning and control can be applied in the most difficult case, and so that thence he may deduce for himself how they can be applied in his own organisation, which may be smaller or larger than the imaginary factory under consideration.

1. Initiation of Production.

Manufacturing instructions must, of course, be conditioned in the first place by sales policy and requirements, and must then emanate from the executive head of the organisation—the general manager or managing director. It is usual for each such instruction to be considered in conference by the interests of design, sales, production, and accounts, under the chairmanship of this official.

The sales interests must decide if the product submitted by the design department will satisfy known market requirements and, if so, how many of the product will be absorbed by the market, and at what price.

Production interests must decide if the design is suitable for production, and if the quantity recommended by the sales department is sufficient, and must submit estimates for the period required to get into production, maximum production rate, and capital expenditure necessary to provide tools, equipment, and plant which will be necessary.

Accounting interests must advise upon a selling price based upon the suggested initial quantity to be produced.

Generally, of course, these decisions will have been worked out beforehand by consultation between the departments affected, but it is not possible to proceed with manufacture until the decision has been ratified by the representative of the Board of Directors, who will have to endorse the decision of the managing director at the next board meeting. Thus the instruction to proceed with production may take the form of a minute of a managing director's conference—or it may be in the form of a written instruction from that official to the production departments.

Where production is put in hand only upon the receipt of definite contracts from customers, such careful procedure to lay responsibility for the manufacturing instruction with the board of directors becomes unnecessary; but wherever expenditure on production work is to be authorised in advance of direct sales contracts, the vast sums involved must be properly—we might almost say, legally—authorised.

The decision on manufacturing policy having been reached, the design department must stand or fall by the drawings it has prepared; the sales department is committed to sell a given number of the product; and the production department must put in motion the machinery of production.

Initiation of manufacture is completely the responsibility of production control: this department must foster and control the arrangements for production from receipt of the management authorisation to proceed until the product is completed and passed over to the sales department for distribution. Procedure for initiating production may be summarised as follows :—

(*a*) Ensure that complete specification of product has been received from drawing office;

(*b*) Issue general production instructions to all factory interests, stating number of sets of material to be ordered, date for completion of first sets, following rate of production, and allocating a works order number—or cost allocation symbol—to which the costs of all work and materials required for execution of the instruction must be charged;

(*c*) Preparation of individual production release authorities for each new component to initiate preparation of process layout instructions, new jigs, tools, and fixtures required, and progress planning data;

(*d*) Decide whether new parts are to be made within the factory or bought out-finished;

(*e*) Prepare stock control record for each part required, and issue requisitions on buying department for total quantities of materials required;

(*f*) Prepare purchase enquiries and issue to possible sources of supply;

(*g*) Receive quotations for supply and decide source in relation to price, delivery, and quality reputation of supplier;

(*h*) Place purchase order with copies to :—

> Purchase record;
> Accounts (certification of invoices for payment);
> Accounts (works costing);
> Production control;
> Goods receiving store;

(*i*) Decide process of manufacture—prepare process layout instruction—specify jigs, tools, and equipment to be used on specified machines at each processing operation;

(*j*) Decide economic batch quantity, and period necessary for production of one batch;

(*k*) Prepare factory schedules specifying commencing date and rate of manufacture;

(*l*) Prepare material delivery schedules showing rate of delivery of materials necessary to enable factory schedules to be achieved;

(*m*) Prepare jig, tool, and equipment availability delivery schedules to show the date when each item of any new equip-

ment required must be ready in order to maintain the production programme;

(*n*) Control ingress of material supplies to the material delivery schedule. Receive material, submit for physical and chemical inspection, and pass to rough material stores;

(*o*) Issue factory order to authorise production of each batch of work;

(*p*) Issue detailed instructions for each batch as to the dates at which each processing operation must be completed;

(*q*) Control rate of progression of production material through manufacturing operations—by progress action;

(*r*) Accept finished materials into finished part stores;

(*s*) Issue programme of work for assembly department;

(*t*) Prepare sets of finished material in accordance with drawing office specification lists, ready for issue to assembly department to maintain assembly programme;

(*u*) Prepare list of stores shortages of material not available to meet assembly programme;

(*v*) Take urgent progress action to clear shortages on sets of material ready for issue to assembly;

(*w*) Issue finished material in sets to assembly department;

(*x*) Ensure that assembly programme is maintained—by progress action;

(*y*) Take care of final alterations to component parts found necessary upon assembly of first production sets of material by :—

> Having production drawings altered;
> Adjusting stock control requirements;
> Altering work in progress materials, and any finished stocks, to revised production drawings;
> Providing modified parts to assembly on first priority basis.

2. Stock Control.

No production planning procedure can operate unless it is possible for the correct production position of each part to be ascertained quickly and accurately. By " production position " is meant :—

(*a*) Total requirements;
(*b*) Models on which part is used;

(*c*) Total quantity of raw material outstanding from suppliers;

(*d*) Quantity of material in rough stock;

(*e*) Production orders in hand in the factory and number of pieces of material on each order;

(*f*) Number of completed parts in finished part stores;

(*g*) Number of parts to be issued to assembly—or delivered direct to customer—to complete outstanding commitments or orders.

To satisfy this need it is obviously necessary that a centralised system of stock control be set up. If the method of organising such a system is satisfactory, it should be possible to eliminate all other production stock records within the organisation.

An example of this kind of centralised control record is shown in Fig. 12.

The work of such a stock control department can be divided into simple clerical work which can be undertaken by female staff, and responsible clerical work which can be delegated only to senior clerical workers. The more important responsibilities of the latter can be as follow :—

(*a*) Initiating new stock control records for parts not previously produced;

(*b*) Issuing "production release" notices to process and rate setting department, jig and tool department, and progress planning department for each new part;

(*c*) Requisitioning materials which must be purchased to cover the requirements of each part in production;

(*d*) Authorising making of patterns for castings, dies for drop forgings, tools for pressings, etc., when purchased from external sources;

(*e*) Issuing works orders authorising batches of rough material to be released to the factory for production;

(*f*) Adjusting stock control action in accordance with drawing office alteration notices;

(*g*) Allocating finished material to orders on hand according to relative urgency of demand.

The simpler clerical operations will be concerned with recording receipts and issues of materials under each section of

the stock control record—information being carried to the clerks by material movement documents—the more important being :—

(*a*) Copy of purchase order for materials;
(*b*) Goods received note;
(*c*) Goods rejected note;
(*d*) Works order and material requisition;
(*e*) Inspection reports for manufacturing scrap;
(*f*) Final inspection certificates;
(*g*) Finished part stores issue lists.

In view of the fact that such records are valueless unless they are up-to-date and completely accurate, close supervision is necessary. Strict rules must be laid down that the records must not be more than 4 hours behind actual stock movements—and the routing of material movement documents speeded up accordingly. It is also important to have periodic stock inventories to prove the accuracy of the records. Fortunately, this last point is covered indirectly under the Companies Acts, since the whole of the work in progress materials should be physically checked and their value certified for the purpose of preparing the company's balance sheet for audit. This periodic check is known as stocktaking. It is usually carried out at a specified time each year, when production is suspended while the physical count is made. Another method, which overcomes the difficulty of suspending production, is called "perpetual inventory", under which auditors will accept stock record figures providing a competent and reliable person is kept continuously employed checking physical stocks against the figures shown on the records and maintaining a register of all counts made and discrepancies found.

There are two principal methods of controlling stocks :—

(1) By requisition against definite contract commitments—plus allowance for wastage—for each part or type of material;

(2) By fixing maximum and minimum stock figures for each type of material and, when the stock falls to the "minimum stock" figure, by ordering a sufficient quantity to bring it back to the "maximum stock" position.

Where :—

Mi. = Minimum stock ;
Mx. = Maximum stock ;
R. = Consumption rate ;
T. = Time to get fresh supplies ;
S. = Safety margin ;
P. = Proposed period between re-ordering ;

the " minimum stock " figure can be fixed as follows :—

$$\text{Mi.} = \text{R.} \times \text{T.} + \text{S.};$$

and the " maximum stock " would then be :—

$$\begin{aligned}\text{Mx.} &= \text{R.} \times \text{T.} + \text{R.} \times \text{P.} \\ &= \text{R.}\ (\text{T.} + \text{P.}).\end{aligned}$$

3. Process Planning and Rate Setting.

Ability to plan production depends completely upon predetermination of the exact amount of work to be done at each separate operation in the manufacture of the product. This is important for the following chief reasons :—

(*a*) Each machine operator must be told precisely what work he is to do at the operation allotted to him;

(*b*) Jigs and tools must be specified so that they may be designed and made in advance of the work being done;

(*c*) The number of machines and amount of production equipment necessary to achieve a given output can only be determined if the time to be spent on each operation is known in advance;

(*d*) It is necessary to estimate production costs in advance of manufacture in order that selling prices can be fixed;

(*e*) For the same wage return, each worker in a factory should be expected to do the same amount of work as his fellows—no more and no less.

The measurement of work effort is by no means simple if great accuracy is desired—from F. W. Taylor to Bedaux there is a vast literature covering method and ethics of work-measurement systems. In Britain there has always been a reluctance to go to the lengths practised in the U.S.A., consequently the subject bristles with controversy. While the highly technical Bedaux system is in operation in some British

factories, it is by far the more common practice to leave the production foremen to fix operation times or piece rates. But as the need for planning production in a systematic manner becomes more urgent, this latter practice becomes superseded by the installation of specialist departments whose sole responsibility is to decide the process of manufacture for each

PROCESS LAYOUT INSTRUCTION

Part Name: Piston and Rod. *Part No.:* G.27020.
Material: List No. 9 Stamping. *Date:* Sept. 29th.
Type: 6 HT. Mark III. *No. off:* 2.

Oper. No.	Tools.	Operations.	M/c Sym.	Dept. No.	Time Allowed.		M/c Setting Time, Mins.
					Hrs.	Mins.	
		STAMPINGS TO BE SUPPLIED HEAT TREATED NO. 9B INSTRUCTION.					
1		Z.25. Sandblast.		GI	—	—	—
2		Hold on stem, rough turn dia., rough faces and remove surplus metal from recess.	CCA	BF		15	90
3	FORM TOOLS G.27020–3A, 3B	Hold on dia., turn stem, face flange, rough and finish, recess and radius face to length and chamfer end.	CCE	BF		27½	90
4	FORM TOOL G.27020–4A	Hold on stem, finish turn dias., groove, face, radius and re-centre.	CCE	BF		12½	90
5		Straighten	SPA	GR		3	—
6		Flash stem for 50 mm. from ball end to 15·5 mm. plus, minus 0·001 in. dia.	EGE	GR		3	20
7	FORM TOOL G.27020–7A	Form spherical.	ELD	PQ		5¼	30
8	FEMALE CENTRE SL.742B–4A	Turn taper.	ELD	PQ		7¼	30
9		Stamp.	SLAB	PQ		½	—

FIG. 13.

part, and to fix the standards of work effort involved at each stage of the process. There appears to be no common policy amongst manufacturing organisations in the choice of personnel for this highly important function in production planning—on the one hand, personnel of the university graduate type are recruited in order that a scientific approach to the work shall be encouraged; on the other hand, it is typical of the British method that the more promising workmen should be promoted

for the task. This latter procedure is generally justified on the score that only the experienced worker on the job knows all the snags—all the petty difficulties which arise, even in the best-organised workshops—and undoubtedly, in practice, the workers get a fairer deal from the application of these ideas. In the interests of improvement and general efficiency, however, it is necessary that a leavening of scientifically trained ability be applied in this sphere of the production organisation.

DETAILED PROCESS OPERATION STUDY

Part Name: Piston and Rod.	*M/c Symbol:* CCE.	*Part No.:* G.27020
Mat.: List No. 9 Stamping.	*Operation:* 3. Hold on dia. etc.	

	Details.	Time.		Details.	Time.
1	Set in chuck and true up	1·50			
2	Index	0·10			
3	Chamfer end for box tool	1·00			
4	Index	0·10			
5	Turn stem 10·5 × 150 – 120	13·00			
6	Index	0·10			
7	End up	0·50			
8	Index	0·10			
9	Chamfer end	0·50			
10	Index	0·10			
11	Rough recess H.F.	4·00			
12	Index	0·10			
13	Finish recess (hand feed)	4·00			
14	Remove job	0·25			
15	Gauge	0·20			
	Fatigue allowance (B) = 8%	2·00			
		27·55			
	Machine Setting Time	90·00			

Actual Time:	*Time Limit:*	*Date:*	*Signed:*
27·55	27½ mins.	20/6/1939	

FIG. 14.

The work of a process and rate setting department centres upon the preparation of:—

(*a*) Fully particularised process layout instructions for issue to the manufacturing departments (see Fig. 13, p. 80);

and

(*b*) Detailed process operation studies showing how the time—or price—allowed for carrying out a given operation is arrived at (see Fig. 14, above).

The preparation of a process layout instruction necessitates setting down the following information :—

(*a*) Detailed description of each operation to be performed, stated in correct sequence;

(*b*) The manufacturing department to be responsible;

(*c*) The type of machine on which each operation is to be carried out;

(*d*) The time limit—or price—to be allowed the worker for completing one off the part concerned at each operation;

(*e*) The time to be allowed for " setting up " the machine at each operation;

(*f*) Details of the special tools and equipment which must be used in conjunction with the machine at each operation.

Methods of manufacture as dictated by the descriptions of work to be done at each operation must, of course, be standardised. This is very difficult, unless the drawing office has been helpful to production by allocating part numbers in a manner such that all components of the same type fall into the same sequence of numbers : if this has been done, however, even if no similar part has been made previously, it becomes comparatively easy to fix a process which takes into account previous experience of doing similar work. The manufacture of entirely new parts must be discussed thoroughly with all who can contribute knowledge before the process is fixed. In many organisations a manufacturing process sub-committee comprising the following interests :—

Process and rate setting,
Jig and tool design,
Production supervision,
Drawing office,
Material supply,

is responsible for deciding the new methods.

In allocating each operation to the appropriate manufacturing department, due cognizance must be taken of the existing production load on the machines which will be involved.

There are two factors to be clearly indicated in specifying the type of machine to be used at each operation :—

(1) The kind of machine—viz., "turret lathe", "horizontal milling machine", etc., etc.; and

(2) The size of the machine.

A simple way of doing this is to allocate symbols for each type and size of machine available within the plant—thus :

CTA = No. 9 Herbert Chuck Turret Lathe.
Max. length spindle to turret 48 in., swing over saddle $12\frac{1}{2}$ in. dia., spindle bore $3\frac{5}{8}$ in.

CTB = No. 16 Type Herbert Chuck Turret.
Max. length spindle to turret 54 in., swing over saddle 15 in. dia., spindle bore $2\frac{5}{8}$ in.

CTC = No. 17 Type Herbert Chuck Turret.
Max. length spindle to turret 78 in., swing over saddle 15 in. dia., spindle bore $5\frac{5}{8}$ in.

CTD = 13 in. Type Ward Chuck Turret.
Max. length spindle to turret 72 in., swing over saddle 17 in. dia., spindle bore $6\frac{1}{4}$ in.

Under this and similar procedures it merely becomes necessary to quote the appropriate machine symbol for each operation.

There is a tendency in some factories to attempt to specify the individual machine tool on which each operation is to be performed. It is seldom possible, however, to keep such accurate office records of the detailed adaptation of each machine tool to do various work, and such an attempt to plan detail leads to endless minor queries between production supervision and the process engineer. It can also be deprecated on the score that it abrogates the production foreman's responsibility of deciding which machine operator and which out of a group of similar machines is best for the job.

The time limit—which must obviously be the "floor-to-floor time" for producing one off at each operation—is taken from a detailed process operation study. This is a summary of the calculations which have been made to arrive at the total time for each operation: the operation is divided into the smallest possible increments of work, each of which is analysed and an increment of time allowed based upon standardised times. The sum of these increments of time represents the total theoretical minimum time in which the operation can be performed. A fatigue and personal allowance must be added to

this, ranging between 8% and 20%, according to the nature of the work and the conditions under which it is to be performed.

"Setting-up" times are best covered by standards fixed for each machine type and size: exceptional cases may occur, however, where special times must be allowed for this work. Included in the "setting-up" time must be an allowance for "clocking-on" the job, fetching drawing and special tools from drawing and sub-tool stores, and, finally, "breaking down" the set-up when the batch of work is completed.

Some system of numbering the special tools and equipment required for each operation is obviously necessary, so that these can be quoted against each operation on the process layout instruction.

It will be noted that in this description of the methods used by a process and rate setting department no mention has so far been made of the use of a stop-watch. The floor-to-floor times mentioned are arrived at by theoretical consideration of the work to be done: of necessity they must be fixed in the initial stages of planning production, possibly many months before the work is to be carried out in the manufacturing shops. The use of the stop-watch in Britain is a matter which still tends to cause some disturbance between workers and managements. Undoubtedly, the flourishing of stop-watches in a factory puts workers on edge: there is a natural resentment that their efforts should be analysed out to the nearest hundredth of a minute—and, in any case, it is usually unnecessary. The only time where the stop-watch should be used is when a worker finds the time he has been allowed to carry out an operation is insufficient and asks for the time to be checked. He must, of course, do this through his foreman, who should make a written "time investigation" request to the process and rate setting department. The rate setter who fixed the time must then take from the records the detailed process-operation study covering the operation under review, and time the worker on the job with a stop-watch, in order to ascertain in what respect his study did not cover the work to be done, and make adjustments if necessary. If no adjustment is necessary, both production foreman and worker must be shown how the work is to be done in the time allowed. A much happier attitude towards stop-watches exists where the workers know that they

will only be used when they themselves request an operation time to be checked.

Methods of stop-watch measurement should be on the "cycle-time" principle, for which the "split-decimal" type stop-watch is essential.

4. Planning Progress of Work.

In the foregoing we have now built up sufficient organisation to introduce progress planning controls. Before describing how these are applied in practice, however, it is necessary that the theoretical aspects of work flow be examined.

Theoretical Aspect of Work Flow.—Whatever the type and complications of production, the fact of placing men at machines causes the following pre-requisites :—

(*a*) Production material must be brought to each machine in batches of a suitably controlled quantity;

(*b*) Work must start on each batch of production material a sufficient period ahead of the required finishing date to enable it to progress through the various processes at a normal rate;

(*c*) All necessary information as to work to be done must be ready before the work is started;

(*d*) All tools, jigs, or fixtures must be available and ready before work is started;

(*e*) The number of men and machines employed on each of the different production processes must be in strict proportion to the amount of each type of work involved in manufacturing one of the product, the time, estimated or known, being multiplied by the rate of production desired.

Once these conditions have been satisfied, work should flow through the production unit at a normal rate, and it should be possible to fix the time required for a batch of work to progress through a given number of operations. This normal rate of flow of work is governed by two main factors—firstly, by the locations of the various processes within the plant layout, and secondly, by controlling the quantity of material to be machined in each batch. Of these two factors the second is the more important, since the fixing of batch sizes obviously influences the total bulk of work in progress. The rate of

flow of production material is in inverse relation to the total bulk of work-in-progress—in much the same way as water flowing at a given volumetric rate will travel slowly through a pipe of large cross-section, while it will flow quickly through a pipe of small cross-section. Thus, if the total quantity of material in the factory is very large, it will take a long time for an individual batch to filter through; whereas if the amount of work-in-progress is restricted, batches will have to pass from machine to machine very rapidly if the plant is to be kept in continuous production.

Since the total bulk of work-in-progress is extremely important from the financial point of view—representing as it does a considerable "tie-up" of working capital—batch sizes cannot be indefinitely large. On the other hand, each time a machine tool is set up to do a given job, a large enough quantity of parts must be produced to reduce the cost of setting up the machine to a very small proportion of the machining cost of each piece. This naturally controls the minimum economic quantity to be machined.

Providing, then, that we have found some way of deciding what is an economic batch quantity, and providing also that we can find some way of deciding the rate at which a batch of parts will flow through the production processes, it should be possible to arrange to insert the batch of material into the work-flow a sufficient time ahead of the date when the work must be completed, so that it will arrive at this point at the normal rate of flow.

Practical Aspect of Work Flow.—In many British factories batch sizes are not controlled; consequently the total bulk of work in progress at any time just happens, and is not the result of any pre-planned consideration. In order to arrange for the work to proceed through each manufacturing process to completion in accordance with some pre-planned schedule, a strong progress department is necessary. Experience in such organisations shows, however, that no management would authorise the expense which would be involved to have a progress department big enough to be capable of controlling flow of each batch of work to the complete satisfaction of all concerned. A progress system which is required to record and urge the performance of each operation on each batch of material is foredoomed to failure, either by unsatisfactory

results or by wear and tear on the mental capability of progress personnel.

The object of a progress planning procedure is to :—

(*a*) Arrange that the greater part of production work is carried out in accordance with a pre-planned schedule;

(*b*) Provide means for showing up the smaller proportion of production work which is not proceeding to schedule;

(*c*) Arrange for systematic progress urge in order to bring (*b*) into line with (*a*).

Such a scheme leaves the progress personnel entirely free to deal with those jobs which for some reason have fallen behind scheduled production rates.

From the theoretical considerations outlined in the foregoing it is obvious that if some measure of control can be exercised over batch quantities, we shall be on the first stage towards achieving this result.

Methods of arriving at the economic batch quantity vary between different organisations. One example of method is to arrange that the minimum economic batch quantity at any given operation is that which gives a production run, on the machine involved, five times the time allowed for setting-up the machine.

Fig. 15, p. 88, illustrates how, under this scheme, a different economic batch quantity will be arrived at for each operation.

Obviously, in practice, a compromise is necessary, and this is effected by taking an average of the minimum economic batch quantity and multiplying this average by two or three to give the normal economic batch quantity. This is found to work very well; since on most operations the machine operator is allowed a production run which can be up to four or five times the minimum economic batch quantity, while, on the other hand, machines on which long operation times are necessary do not become tied up for abnormally long periods on one batch of work.

This example is a fairly advanced method of arriving at batch quantities. It may be noted, however, that in many organisations very simple rules are adopted, such as "the batch quantity for each component must comprise sufficient material for 2–3 weeks' production requirements". Obviously there are serious snags in the application of rules of this simple

character. The best that can be said for them is that they are one stage better than fixing no rules at all.

The second primary requisite in order to be able to plan the production of any given batch of work is, as we have said, to decide the rate at which it will flow through manufacturing

CHOICE OF ECONOMIC BATCH SIZE

Part No.: G.27020—Piston and Rod/Brake/Air.

Operation No.	Machine type.	Operation time.	M/c setting time.	Minimum economic batch.	Average minimum economic batch.
1	Sandblast	—	—	—	
2	CCA	15	90	$\frac{90 \times 5}{15} = 30$	
3	CCE	27·5	90	$\frac{90 \times 5}{27\cdot5} = 16$	
4	CCE	12·5	90	$\frac{90 \times 5}{12\cdot5} = 36$	
5	SPA	3	—	—	27
6	EGE	3	20	$\frac{20 \times 5}{3} = 33$	
7	ELD	5·25	30	$\frac{30 \times 5}{5\cdot25} = 29$	
8	ELD	7·5	30	$\frac{30 \times 5}{7\cdot5} = 20$	
9	SLAB	0·5	—	—	

The MINIMUM ECONOMIC BATCH is where the production run is five times the time allowed for setting up the machine.

BATCH SIZE TO BE CHOSEN EQUALS: "Average Minimum Economic Batch" MULTIPLIED BY TWO—*i.e.*, 27 × 2 = 54. For practical purposes this will be taken as 60.

FIG. 15.

operations. This can be ascertained quite well in practice by observing the length of time which it takes for a batch of work to go through the following stages :—

(*a*) Issue of material from stores;

(*b*) Cutting time on each machine—*i.e.*, batch quantity multiplied by time allowed per piece;

(*c*) Floor inspection;

(*d*) Transport from one machine to another and from one department to the next;

(*e*) Period of time a batch of work has to wait before going into operation on a machine—*i.e.*, waiting while work

MEASURING THE PRODUCTION PERIOD

Part No. : G.27020.						*Economic Batch* : 60 off.		
Op.	M/c.	Bay.	Op. mins.	Job hrs.	Waiting hours.	View and transport.	Total hours.	Weeks.
(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)	(*g*)	(*h*)	(*i*)
1	SB	GI	—	8	8	—	16	1
2	CCA	BF	15	15	18	8	57	1
3	CCE	BF	27·5	28	18	—	103	2
4	CCE	BF	12·5	13	—	—	116	2
5	SPA	GR	3	3	8	8	135	2
6	EGE	GR	3	3	12	—	150	2
7	ELD	PQ	5·25	5	12	8	175	2
8	ELD	PQ	7·5	7	—	—	182	2
9	SLAB	PQ	0·5	1	8	8	199	3
PRODUCTION PERIOD BASED ON 94 PRODUCTION HOUR WEEK =								$\frac{199}{94}$
							=	2 weeks

FIG. 16.

already in operation is completed, and while other batches of work which have arrived before are also completed.

Anyone familiar with conditions in a given workshop can fix standards for these increments of production time. The waiting times will generally be found to vary for each type of machine. For instance, on capstan lathes it may be found

that only one batch of work is waiting to be done on each machine, whereas on final grinding operations it may be that three or four batches of work wait at each machine. It is fairly easy to arrive at the total number of hours which are equivalent to the amount of work usually waiting for each particular machine group.

The total time to be allowed for a part to progress through the manufacturing operations from the issue of the rough material to receipt of completed parts from the inspection department can be arrived at in a manner similar to that set out in the planning study shown in Fig. 16, p. 89. Columns *a*, *b*, *c*, and *d* are obtained, of course, from the process layout instruction prepared by process and rate setting section. The economic batch quantity can be arrived at as in Fig. 15. Under Columns *f* and *g* are shown standard waiting periods which have been fixed and charted for each type of machine and process in each department. Column *h* shows the cumulative production hours absorbed up to each operation. The total number of production hours is shown against the last operation. If this figure is divided by the number of production hours being worked per machine each week, the total number of weeks to be allowed for a batch of predetermined quantity to go through all processes is obtained.

Providing that we can take similar action to arrive at the production period which must be allowed for the manufacture of each part in current production, it will be possible to plan :—

(*a*) Precise arrival dates for each batch of material; and

(*b*) The approximate dates at which each manufacturing operation on every batch of production material must be completed;

which will fit in with the general normal rate of flow of work through the factory; and it should be unnecessary for progress urge intervention unless :—

(*a*) Material has not become available at the correct starting date;

(*b*) Tools have not been ready to enable the operations to be carried out on the date specified;

(*c*) The flow of the batch through production has been inter-

rupted through process difficulties or machine breakdowns; or

(*d*) Production resources have fluctuated to cause bottlenecks.

5. The Plan of Production.

Having prepared the planning data, we must now examine our ability to set up a master plan for the whole of the factory output and all those phases of the manufacturing processes upon which factory output depends. It is interesting, at this stage, to note that the methods of planning and scheduling production, now to be described, apply to flow production conditions as well as to batch production.

The plan of production is therefore prepared in five sections :—

1. A *Target Date Chart* showing, for a new product, the dates by which each production facility must be ready and each phase of production completed in order that the completion date for the first sets of material can be achieved;
2. A master *Production Schedule* showing rate of completion of all models in current production;
3. A *Factory Schedule* showing rate of production necessary for all parts on which manufacturing operations are carried out within the plant;
4. A *Material Delivery Schedule* showing rate at which sub-contractors and suppliers must complete and despatch rough and bought-finished materials;
5. A detailed *Jig and Tool Availability Schedule* showing the precise date by which each item of new production equipment must be made available.

The Target Date Chart is necessary to set down clearly the periods to be allowed for the completion of each phase of the work necessary before finished production can commence on a new product. Such a chart is only necessary for the first quantity of a new product, and need not be maintained for following batches once the momentum of production has been obtained. Fig. 17 is an example giving dates for commencing and finishing each major operation on a new product which takes six months to get into production. Such a plan of action can, of course, only be prepared as a result of consultation

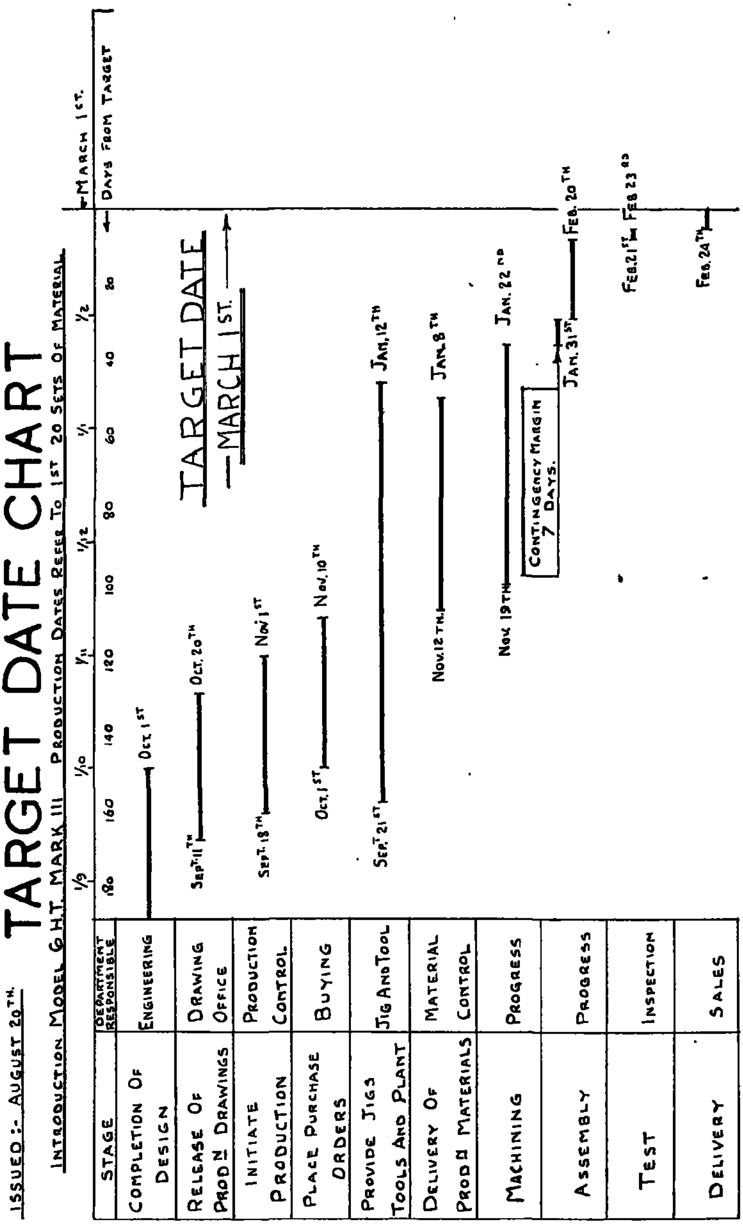

ISSUED :- AUGUST 20TH.
TARGET DATE CHART
INTRODUCTION MODEL GHT. MARK III PRODUCTION DATES REFER TO 1ST 20 SETS OF MATERIAL
TARGET DATE
MARCH 1ST.
MARCH 1ST.
DAYS FROM TARGET
STAGE
DEPARTMENT RESPONSIBLE
COMPLETION OF DESIGN
ENGINEERING
OCT. 1ST
RELEASE OF PRODN. DRAWINGS
DRAWING OFFICE
SEPT. 11TH
OCT. 20TH
INITIATE PRODUCTION
PRODUCTION CONTROL
SEPT. 18TH
NOV. 1ST
PLACE PURCHASE ORDERS
BUYING
OCT. 1ST
NOV. 10TH
PROVIDE JIGS TOOLS AND PLANT
JIG AND TOOL
SEPT. 21ST
JAN. 12TH
DELIVERY OF PRODN. MATERIALS
MATERIAL CONTROL
NOV. 12TH.
JAN. 8TH
MACHINING
PROGRESS
NOV. 19TH
JAN. 22ND
CONTINGENCY MARGIN 7 DAYS.
ASSEMBLY
PROGRESS
JAN. 31ST
FEB. 20TH
TEST
INSPECTION
FEB. 21ST
FEB. 23RD
DELIVERY
SALES
FEB. 24TH
1/9
1/10
1/11
1/12
1/1
1/2
180
160
140
120
100
80
60
40
20

FIG. 17.

between design, drawing office, factory engineering, jig and tool department, production control, and production supervision.

The Production Schedule really constitutes the master plan for the whole of the production output of a plant. It specifies the quantities of each type of product which will be made available to the sales department during each production period (see Fig. 18, pp. 94–95)

The most important part of such a document is obviously the total output which it specifies. This depends in the first place on the rate at which the products of the manufacturing organisation can be absorbed by the market. The maximum output which can be scheduled, however, depends on the maximum volume of production which can be handled by the manufacturing facilities available. It is clear, then, that one of the first essentials in the fixing of a production schedule calling for maximum output is to know precisely what the maximum total volume of production is. This important information can only be obtained accurately by preparation of a complete analysis of the amount of each type of work in the product, expressed in hours; and by dividing this, section by section, into the maximum number of machine hours which can be worked each week on each type of process. Thus, if the total number of external grinding machine hours which can be worked each week is 1,504 and each product absorbs 11·5 hours of external grinding capacity, the maximum output of the external grinding plant will be $\frac{1{,}504}{11\cdot5} = 131$ product sets per week. In setting up a new plant, or expanding a plant to reach a given output, obviously the converse reasoning applies—*i.e.*, the total amount of each type of work in the product expressed in hours is multiplied by the output required in sets per week, from which it is possible to calculate the number of each type of machine and each piece of production equipment required to maintain the specified output. In dealing with maximum production conditions, it is always necessary to allow a contingency margin (1 to 3% for flow production conditions, and up to 10% for batch production conditions) to take care of :—

Machine breakdowns;

Re-machining of faulty materials and faulty work;

Sudden, unplanned, demands upon manufacturing capacity.

Production Schedule

Issued: November 8th.

Model.	Cost Allocation Symbol.	O/S.	December.				January.					February.			
			6	13	20	27	3	10	17	24	31	7	14	21	28
			49	50	51	52	1	2	3	4	5	6	7	8	9
6 H.T. Mark III	WF	500										5	5	10	10
6 S.D.P. Mark VII	VT	1500	24	24	26	26	28	28	30	30	32	32	34	34	36
4 S.D.P. Mark VII	VS	490	15	15	15	15	15	15	15	15	15	15	15	15	15
4 S.W.T. Mark I	VQ	700	20	20	20	20	20	20	20	20	20	20	21	21	21
6 L.W. Mark I	VO	80	10	10	9	9	8	8	7	7	6	4	2		
4 L.W. Mark I	VP	60	6	6	6	6	6	6	6	6	6	3	3		
Total per Week			75	75	76	76	77	77	78	78	79	79	80	80	82
Spares			£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000

Model.	Cost Allocation Symbol.	O/S.	March.				April.					May.			
			7	14	21	28	2	9	16	23	30	7	14	21	28
			10	11	12	13	14	15	16	17	18	19	20	21	22
6 H.T. Mark III	WF	500	15	15	20	20	25	25	30	30	30	30	30	30	30
6 S.D.P. Mark VII	VT	1500	36	38	38	40	40	40	40	40	40	40	40	40	40
4 S.D.P. Mark VII	VS	490	15	15	15	15	15	15	15	15	15	15	15	15	15
4 S.W.T. Mark I	VQ	700	16	16	11	11	6	8	3	5	5	5	5	5	5
6 L.W. Mark I	VO	80													
4 L.W. Mark I	VP	60													
Total per Week			82	84	84	86	86	88	88	90	90	90	90	90	90
Spares			£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000	£31,000

Issued: December 13th.

Model.	Cost Allocation Symbol.	O/S.	January.					February.				March.				April.					May.				June.			
			3	10	17	24	31	7	14	21	28	7	14	21	28	2	9	16	23	30	7	14	21	28	4	11	18	25
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
6 H.T. Mark III	WF	500							5	10	15	15	15	20	20	25	25	30	30	30	30	30	30	30	30	30	30	30
6 S.D.P. Mark VII	VT	1404	24	24	24	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	40	40	40	40	40

Issued: January 10th.

Model.	Cost Allocation Symbol.	O/S.	February.				March.				April.					May.				June.				July.				
			7	14	21	28	7	14	21	28	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
6 H.T. Mark III	WF	500		5	10	15	15	15	20	20	25	25	25	30	30	35	35	35	35	35	35	35	35	35	35	35	35	35
6 S.D.P. Mark VII	VT	1284	28	28	35	35	35	35	35	35	36	36	36	36	36	36	36	36	36	36	37	37	37	37	37	37	37	37

November 8th Issue confirms original plans for starting production of Model 6 H.T. Mark III by w/e February 7th.
December 13th Issue showing deferment of starting assembly of Model 6 H.T. Mark III by one week, increases acceleration of building by +5 in w/e February 28th. On Model 6 S.D.P. Mark VII it has been found necessary to keep output for January down to 24 per week.
January 10th Issue confirms maintenance of starting date for Model 6 H.T. Mark III, but increases ultimate building rate to 35 per week. On Model 6 S.D.P. Mark VII early production can be increased but ultimate cannot exceed 37 per week.

Fig. 18.

The chief difficulty in fixing output under a production schedule, however, occurs when market demands cannot be estimated accurately more than one or two months ahead. Under such conditions it becomes necessary to keep issuing revised schedules each month, as shown in Fig. 18. The production shown in the first month of the schedule must, of course, be positive. The output specified for the second and third months must be the closest possible estimates of sales demand, while production specified for the fourth, fifth, and sixth months is so tentative that it can be described only as an intelligent guess at what will be required. It is, however, very important to make this "intelligent guess" when the longest-production-period components have to be put in production four or five months before completion—as is frequently the case. In light engineering work, where production periods do not exceed four weeks, obviously "intelligent guessing" can be dispensed with.

The Factory Schedule is compiled in sections—one for each *manufacturing department. Its object is to show the rate* at which each component part is to be produced: thus there must be an entry for each component to be produced in the department concerned. Under flow production procedure the factory schedule will show the weekly or daily rate of producing each part; but under batch production conditions, where it may be necessary to manufacture a sufficient quantity of a part to last several weeks of finished-product output, it is clearly necessary to show when each economic batch of work is to be completed (see Fig. 19, p. 97).

The following information must be provided to enable each entry to be made on the factory schedule :—

(*a*) The quantity used on each of the different products and the up-to-date manufacturing position as shown by the stock control record (refer Fig. 12, facing p. 77).

(*b*) The production periods to be allowed for each stage of manufacture as shown by the planning study (refer Fig. 16, p. 89);

(*c*) The rate of production of each type of product as laid down by the production schedule (refer Fig. 18, pp. 94 and 95).

The stock control record will, of course, also show any

FACTORY SCHEDULE

Machine Bay : PQ.					*Foreman :* Smith.															
Part No.	Program.	Economic Batch.	Machining Priority.	Originated.	Completion Dates.															
						December.				January.					February.				March.	
					W/E	6	13	20	27	3	10	17	24	31	7	14	21	28	7	14
					No.	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11
G.27020	6 HT—2 off	60	2	BF					60			60		60		60		60	60	60
G.27091	6 SDP—1 off	120	3	15			120					120				120			120	
G.27092	Spares : 60	30	2	BF										30		30				
G.28630	6 HT—1 off 6 SDP—1 off Spares : 20 p.w.	90	4	FG		90		90		90		90		90	90		90	90	90	90

FIG. 19.

demands supplementary to those of production which may have to be added to the production quantities scheduled.

When scheduling long-production-period components it is necessary to bear in mind the tentative nature of the output figures under the fourth, fifth, and sixth months of the production schedule and, in order to take care of the fluctuations in demand which are likely to occur, to provide a "bank" between the requirements shown on the production schedule and the rate of production specified on the factory schedule. "Bank" is the term used to describe scheduling for the completion of work in advance of the indicated requirement date, so that any subsequent increase in demand can be taken from the "bank" without altering detailed plans which have been made as a result of publication of the factory schedule.

Before the factory schedule for each department is published it must be checked, to ensure that the amount of work being called for is within the capabilities of available plant and labour. The machine capacity absorbed by each batch of work must be analysed for each production period, and a machine-load analysis of the factory schedule issued with it, so that production supervision can arrange in advance for the amount of labour required and the degree of double-shift working and overtime necessary. The machine load should be prepared separately for each manufacturing department, and a final analysis prepared for the whole of the plant—an example of this last document is shown in Fig. 20. If the capacity of the plant has been correctly gauged when planning the main production schedule, no cases of overload should occur: however, extra unplanned demands occur in most factories, and consequently one or two cases of overload must be reduced by obtaining machining assistance from outside organisations. Should a consistent overload be shown on many machine groups which could not be relieved in time by outside assistance, it would then be necessary to re-schedule production completely on a lower output.

The Material Delivery Schedule is also compiled in sections—one for each sub-contractor or material supplier. Its main purpose is to indicate to the outside organisation precisely the deliveries necessary to keep production in both producing units in step (see Fig. 21). The material delivery schedule can be compiled very easily from the factory schedule, by specifying

MACHINE LOAD SUMMARY—BASED ON 94 HOURS/WEEK PER MACHINE

Department.	Lathes.	Capstans.	Turrets.	Bar Auto's S.S.	Bar Auto's M.S.	Chuck Auto's.	Vert. Mills.	Hor. Mills.	Pillar Drills.	Radial Drills.	Multi Drills.	Borers.	Ext. Grinders.	Int. Grinders.	Surf. Grinders.	Univ. Grinders.	Gear Grinders.	Gear Cutters.	Gear Hobs.	Broaches.	Miscellaneous.	
Crankcases							1235	381		2485	91	1085										6177
Non-Ferrous Shop	356	550	183				271	67	248	203	19									17	9	2013
Bearing Shells	705	899	253				245	139	73	197			362							42	160	3125
Cylinders and Heads							213	217	180	2164	178	688			247						428	4815
Brake Drums			219			163				214	8	312		11								927
Sleeves		30	484										259	129								902
Valves and Guides		430	140			105		35					670								235	1711
General	199	548	1235				691	680	779	852	107	62			150					51	284	5638
Connecting Rods	398	133				64	36	369	757	232	28	30		168	101						2	2408
Axles	200		794			794	502	209	246	1260	176	1314	199	136						9	72	6001
Levers	104	123	615			43	454	1055	744	620	137		62	75	27					64	135	4264
Crankshafts	687	220					223			277	136	172	1401	35							588	3744
Driving Shafts	381		562				96		16	92		143	251	116				67	129			1853
Camshafts	155								16												136	307
Chuck Auto's	797	384	1388			1239		518	447	15	104										312	5204
Bar Machines	•	1902	3503	1527	692	161															62	7847
Gearcutters			44						48	60								1353	1139		492	3136
Grinding									23				2255	1097	612	398	1961			232	627	7205
Total Load in Hours per Week	3982	5225	9420	1527	692	2659	4061	3720	3577	8767	984	4706	5459	1767	1227	398	1961	1420	1268	415	3542	66777 (Double Check)
Machines Available	46	52	101	16	5	27	33	53	41	84	16	49	51	15	16	6	22	19	18	8	63	
% Machine Load	92	107	99	101	147	105	131	75	93	111	65	102	114	125	82	71	95	80	84	53	60	

FIG. 20.

MATERIAL DELIVERY SCHEDULE

To Messrs : Thomas Smith, Ltd. *From :* Victory Engineering Co., Ltd.

Part No.	Description.	Order No.	Qty. O/S.	Month. Day.	Over-due.	November.					December.				January.					Feb.	Mar.
						1	8	15	22	29	6	13	20	27	3	10	17	24	31		
G.27020	Piston and Rod/Brake	15032 10/10	1010	To be D/D	—					60			60		60		60		60	240	300
				Actually sent																	
G.27091	Piston and Rod/Brake	6741 7/6	1520	To be D/D	120				120					120				120		120	240
				Actually sent																	
G.27092	Piston/Brake	12451 17/9	60	To be D/D	—												60				
				Actually sent																	
G.28630	Brake Cylinder	7501 8/6 16907 14/10		To be D/D	60		90		90		90		90		90	90		90	90	270	450
				Actually sent																	
				To be D/D																	
				Actually sent																	

All deliveries effected after advice notes dated November 1st *to be deducted from this schedule.*

FIG. 21.

delivery of each batch of production material at a date which anticipates the completion date shown on the factory schedule by the production period necessary for manufacture, plus a margin for rough material stock and a contingency for late delivery.

The Jig and Tool Availability Schedule, similarly, is compiled from the factory schedule; and since it is necessary only for new products, obviously it must be linked with the period allowed for provision of jigs and tools on the Target Date Chart. One form of this type of schedule is shown in Fig. 22, where, under each week, is shown the number of the operation on each new part which must be completed—the tools, jigs, and fixtures being indicated by symbols shown adjacent to the operation number. Thus for Operation No. 4 on Part No. B.76403 a milling fixture, milling cutter, sighting gauge, and spacing collar are required, and they must all be ready before Nov. 1st.

6. Fulfilment of Plan.

Arrangements for ensuring that the plan of production is worked to are divided into :—

Material control;
Work issue; and
Progress.

The ultimate responsibility, of course, rests with the progress department.

Material Control is the designation of the department responsible for ensuring that rough material and bought-finished material arrive to scheduled dates. In some organisations it is part of the responsibility of the purchasing agent—or buyer. Because material control is essentially part of the function of production control, however, the modern tendency is to constitute a separate department to deal with the problem, working in close liaison with the progress department. Material control is operated by keeping a record of the delivery of materials on a copy of the material delivery schedule—the clerks concerned then being responsible for corresponding and communicating by telephone with suppliers when materials do not arrive to specified dates. In war-time special measures have to be taken : large organisations have to allocate engineers to

Jig and Tool Availability Schedule

Tools Required for: Model 6HT Mark III

Tool Abbreviations.

A = Arbor.
B = Bar.
C = Cutter.
D = Dividing plate.
E = Cutter head.
F = Fixture.
G = Gauge.
H = Hob.
J = Jig.
K = Head.
L = Adaptor.
M = Mandrel.
N = Spacing collar.
P = Bush.
R = Reamer.
S = Spigot.
T = Tools.
V = Vice jaws.
W = Jaw.
X = Special parts.
Y = Broach.
Z = Master gear.

Part No.	Description.	Economic Batch.	Production Period.	Model.	W/E Week No.	18/10 42	25/10 43	1/11 44	8/11 45	15/11 46	22/11 47	29/11 48	6/12 49	13/12 50	20/12 51	27/12 52	3/1 1	10/1 2
B.76403	Winch Bracket	20	10	4 SDP Alt.	Tools		T	FCXN	R	JY	FT			TY	JR			
					Ops.		1, 2, 3	4, 5, 6	7	8, 9	10	10	11, 12	13, 14	15	16, 17		
G.27020	Piston and Rod/Brake	60	2	6HT	Tools								T					
					Ops.							1, 2	3, 4, 5 6, 7, 8	9				
H.10438	Shaft.	120	5	6HT	Tools						T	JR	T					
					Ops.						1	2, 3	4, 5	6, 7	8			
V2/36434	Guide	300	2	6HT	Tools									J				
					Ops.									1	2			

Fig. 22.

each producing area in the country, to maintain weekly personal contacts with suppliers. In the case of some key materials, the Government has had to institute " controls " to ensure an even and accurate distribution; and copies of the material delivery schedules have to be submitted to the Government departments concerned for checking and authorisation, before being sent to the suppliers.

JOB ROUTING AND PRIORITY CARD

Batch.			Quantity.			Part number		
WF/50/52			60			G.27020		
Op.	Mc.	Shop.	Week.	Started.	Finished.	O.K.	Scrap.	Viewer.
(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)	(*g*)	(*h*)	(*i*)
1	SB	GI	50					
2	CCA	BF	50					
3	CCE	BF	51					
4	CCE	BF	51					
5	SPA	GR	51					
6	EGE	GR	51					
7	ELD	PQ	51					
8	ELD	PQ	51					
9	SLAB	PQ	52					
	VIEW AND TRANSPORT TO FINISHED PART STORES							
	LOCATION 4							

Note.—Alterations and additions may be made by Office only.
M.1038.

FIG. 23.

Work Issue. Systematic and fool-proof procedure must be laid down in order to ensure that instructions are issued to the factory to enable each batch of work to *start* at the correct date. This involves issuing a works order, accompanied by a requisition to enable the rough material to be drawn from stores: in many organisations all work payment tickets

material movement forms, and inspection notes are issued as part of the works order. This is made possible by mechanical office equipment which prints the appropriate information on each document and binds all the documents for one works order into a book, so that they can be detached at each stage of the progress of the batch of work.

The date for issue of each works order is obtained from the factory schedule by anticipating the finishing date by a period equal to normal production period to be allowed for the work to be done. In order to ensure that each batch of work receives correct priority of treatment at each operation, it is important that arrangements are made to indicate the approximate date when each operation should be carried out. One method of doing this is by issuing a job routing card for each batch, of which an example is shown in Fig. 23. Here the date at which each operation is to be completed is indicated by a week number under Col. *d*. Columns *a*, *b*, and *c* are copied from the standard process layout instruction for the part concerned (refer Fig. 13), while the week number at each operation is arrived at by referring to the planning study (see Col. *i*, Fig. 16). Columns *e* and *f* are filled in by the manufacturing departments when each operation is started and finished; by noting the progress that each job has made in relation to dates specified, it is possible for production supervision to deal with each batch of work in correct priority.

The Progress Department must be made responsible for ensuring that all operations carried out within the organisation are completed to the specified dates, and ultimately that finished product output is maintained strictly to the production schedule.

In any organisation where a large progress staff is necessary, it is highly important to organise their activity into clearly grouped responsibilities (see Fig. 24). In practice it will be found that the progress staff have to make the organisation work—overcome deficiencies of system, supervision, staff, and management. It may therefore be deduced that in the perfectly operated and run factory very few progress clerks will be needed. Unfortunately, every organisation has its deficiencies, even though these result from the ultimate trouble—personnel—and a modicum of energetic progress action must always be necessary.

Earlier we have stated that the object of work control procedure is to leave the progress staff free to deal with jobs which, for some cause, cannot be left to filter through the manufacturing process at normal rate, but must be rushed through by taking priority over other work. The information upon which a progress department would work, assuming the

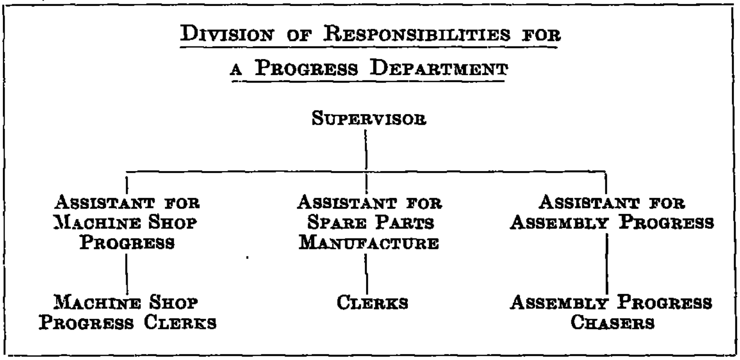


FIG. 24.

system in force to be similar to that which we have examined, is :—

(*a*) List of jobs overdue—arrived at periodically (weekly or bi-weekly), and setting out details of batches more than two weeks behind the operation completion dates shown on the job routing card (refer Fig. 23);

(*b*) " Shortage " on stores issue to assembly, which shows all materials not available to issue for the agreed assembly programme;

(*c*) Direct assembly shortage when action based upon (*a*) and (*b*) has failed (theoretically this condition should *never* arise—but in practice it sometimes does);

(*d*) Drawing office alteration to specification advices;

(*e*) Spare parts overdue lists issued by service department; and

(*f*) A complete " shortage " list of all parts and materials required to complete the first batch of a new model.

(This last source of information is also necessary when production is to be re-commenced on a model which has been temporarily out of production.)

7. Storekeeping and Material Handling.

In many organisations storekeeping is considered to be a function entirely separate from all others; and, by virtue of the fact that the stores is responsible for custody and issue of valuable materials, that it should be part of the responsibility of the chief accountant or the secretary of the Company. In late years, however, there has been a reaction against the sanctity of the storekeeping function, and a tendency to divide the responsibility for custody of materials under the departments on whose behalf materials are held.

Fig. 25 shows a typical division of responsibility for stores in a medium sized factory, showing how each compartment is subject to functional control.

In large factories this method of decentralising location and responsibility for stores becomes essential, since no one man can keep control of such a wide variety of materials. Production storekeeping, also, is an entirely different technique from general storekeeping, in view of the rapid stock turnover which causes special problems in handling and stacking.

An important principle in production storekeeping is that any material which is not in current demand must be eliminated from the stores by passing it to spare parts, surplus, or obsolete stores. This is important, because the value of the material on the Company's books varies according as to whether it is in current demand, in spares stores, or designated as surplus: entirely fictitious costs will result unless the material is correctly segregated under these headings.

We have already discussed a system of stock control for the production group of stores as part of the system of organising work (refer page 77); and the application of such a system can eliminate the need for storekeeping records within the production stores themselves. Under this scheme the storekeepers are merely responsible for handling the material into and out of stock in accordance with the instructions they receive by " booking in " or " booking out " documents.

While a similar kind of centralised stock control procedure can also be applied to service and spare part stores, in the case of the factory service stores, such as the drawing and tool stores, it is highly essential to keep records on the spot under conventional storekeeping procedure—that is, requisitions signed by foremen for all consumable materials issued and tool

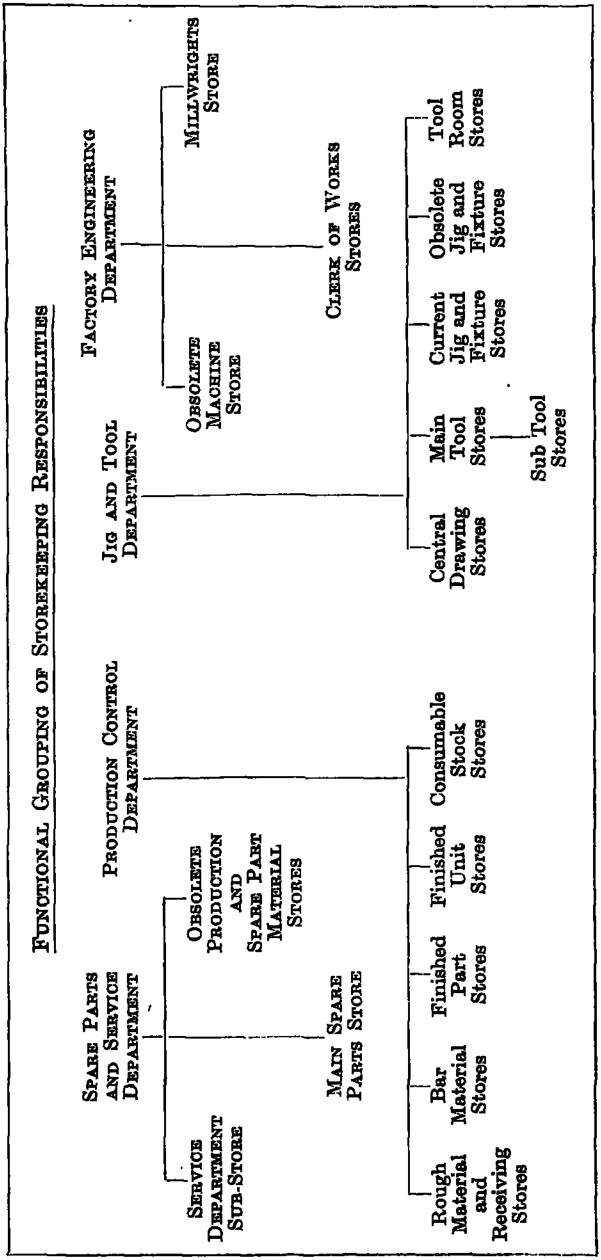

Functional Grouping of Storekeeping Responsibilities
Spare Parts and Service Department
Service Department Sub-Store
Main Spare Parts Store
Obsolete Production and Spare Part Material Stores
Production Control Department
Rough Material and Receiving Stores
Bar Material Stores
Finished Part Stores
Finished Unit Stores
Consumable Stock Stores
Jig and Tool Department
Central Drawing Stores
Main Tool Stores
Sub Tool Stores
Current Jig and Fixture Stores
Obsolete Jig and Fixture Stores
Tool Room Stores
Factory Engineering Department
Obsolete Machine Store
Clerk of Works Stores
Millwrights Store

Fig. 25.

and drawing checks for all tools and production drawings issued to production workers. It is important that consumable materials should be issued from stores only under authority of requisitions issued by responsible officials of the organisation—viz., foremen, heads of departments, etc. Requisitions are a form of demand, issued by a department to obtain materials required to operate that department: they are received by the Stores in exchange for the goods required, are endorsed by the storekeeper with the quantity of material issued, and are then passed to the works costing office, whose responsibility it is to charge the cost of materials used against the department using them, in order to help build up the works oncost charge for that department.

In the goods receiving and rough material stores special procedure is necessary to cover checking in of purchased goods. Procedure is generally as follows :—

(*a*) Receive advice notes from supplier stating goods have been despatched;

(*b*) Receive goods;

(*c*) Check goods against advice note for quantity, part-number designated, and purchase order number;

(*d*) Make out internal document—a "goods received note" with copies to :—

Accounts ;
Production control ;
Inspection ;
Stores (stays with goods) ;

(*e*) Pass material to goods inwards inspection, who are responsible for checking the supplies against specification, drawing, and purchase order;

(*f*) Pass materials, certified correct, to rough material or to finished part store—according to whether they are rough or bought finished materials;

(*g*) Pass any rejected materials direct to goods outwards department for immediate return to suppliers, accompanied by an inspection report.

Material handling becomes a special problem under batch production conditions, because, although the bulk of materials to be kept on the move can be large, there are no general lines

of flow which can be taken care of by conveyor systems such as can be adopted under flow production conditions.

The difficulties in the task can only be resolved by good supervision and a planned routine of work for each material handling appliance. Thus a timed journey programme should be laid down for each internal transport truck, and regular time tables arranged with the railway company for dealing with the daily shunt.

The movement of materials within one manufacturing department, and movement of completed batches of the department, should be made the responsibility of one material transport man, who should be equipped with all necessary appliances to move the special work of the department and special work containers, where these are necessary, for safe handling of certain parts.

Similarly, time tables and regular journeys should be instituted, whenever possible, for external transport operated by the organisation.

The checking of railway and external transport accounts is a worth-while hobby for the transport supervisor—considerable savings can be made on carelessly compiled accounts, and undoubtedly such accounts should always be authorised for payment through the transport department.

CHAPTER VI

THE FOREMAN'S PART

In a large organisation, application of the principles here examined—especially along the lines of the examples used to illustrate method—will limit the direct responsibility of the foreman. At first this may appear to reduce the importance of his function. But, in fact, the converse is true.

The modern conception of the foreman's responsibility is that of department manager; as such he is directly responsible for the application of labour and machines to a prescribed task, and for ensuring that man and machine become an effective combination. To the workpeople their foreman, inevitably, is the representative of the factory management. To the factory officials the foreman is the point of contact of management with the employees. All day-to-day business relations between management and workpeople must be through foremen. Only in exceptional matters does direct representation to management become necessary for the workpeople: when it does, the matters involved are either too big for foremanship solution, or foremanship has failed. Competently to control the activity of a hundred workers—for the foreman is often the centurion of modern industry—he must, theoretically at least, be relieved of all routine. Only by this means can the foreman give full attention to his primary responsibility—supervision of men's work.

Since the application of labour and machines is almost the final phase in organising production, the foreman is the individual who sees, hour by hour, the degree of effectiveness of management and the efficiency of production organisation and planning system. Thus it is vital for him to know, in intimate detail, the precise responsibilities of all who are concerned with the factory and its procedure, so that he may bring to light faults in management and in the operation of the system. Just as the foreman must eliminate bad workmanship and bad discipline within his own department, so also should

he be alive to faults resulting from bad management or bad system imposed upon him. In both cases the essence of good foremanship is to bring faults to the notice of those responsible in a diplomatic but persistent manner until curative action results.

In small factories work turnover may be insufficient to allow responsibilities to be divided into the groupings dealt with in this section. It is under this condition that the foreman must take on responsibilities outside the sphere of the modern conception of foremanship just described. If the organisation is very small, it may well be that the foreman will have to be responsible for all those functions set under "Production" in Fig. 9, page 48, as well as for such labour management as may exist. In a slightly larger organisation he may be relieved of the jobs of attending to factory maintenance, designing tools, and, probably, also of the responsibility for material supply and storekeeping. As organisations become larger the responsibility of the foreman changes from that of general factotum to that of the specialist in directing and obtaining the best from the human energy upon which, in the last resort, the success of a manufacturing unit must depend.

It has been demonstrated that the foreman has a most important part to play in the carrying out of the arrangements. To the extent to which he understands the principles at work, and uses his best efforts to make them effective, he has a great influence on the smooth running of the whole programme and its timely performance.

Lack of knowledge and interest on his part leads to carelessness in detail, and makes the ultimate work of the cost office more difficult and less prompt and effective. Conversely, if he displays an intelligent interest in the work of the planning and progress departments, and does his best to co-operate with them, his shop will be so much the more efficient, to the general benefit of the undertaking and to the particular benefit of himself and those for whose work he is responsible in it.

Not only the foreman, but also the works manager and any working director who is responsible for the production department must fully understand in principle and in detail whatever system is in use in the factory; and each of them in his own sphere of influence must exercise constant supervision to see that everything goes according to plan, including accurate

making out and prompt passing on of all requisitions and records. Neglect or failure to do so will seriously hamper, if not entirely ruin, any system whatever. No system will work itself: it must necessarily depend for its successful application on the goodwill, common sense, and unceasing co-operation of all concerned—from the Board to the bench.

SECTION III

ELEMENTS OF LABOUR MANAGEMENT

CHAPTER I

LABOUR MANAGEMENT AS A FUNCTION OF INDUSTRY

ONLY in comparatively recent times has there been any appreciation of the importance of the study of Labour Management in industry as part of the training of foremen or forewomen. The foreman has an important part to play in the exercising of this function; and until recently it has been a common practice for him to be responsible for carrying out many of the items which are in fact part of Labour Management. It has, however, now become recognised that these responsibilities are of such importance as to demand specialised handling.

One of the greatest lessons of the past twenty years has been that the management of the human beings who form a living part of the industrial enterprise is at least as important as the proper care of the equipment and material used in production. The realisation of this fact has led to the recognition of a special function of management, generally known as " the personnel function ", of which Labour Management may be regarded as a major element.

Broadly speaking, the Personnel Department may be said to have evolved from the need for an industrial concern to make its administration more effective by centralising and coordinating all aspects of personnel management, and its function may be described as a specialised responsibility for ensuring the maximum effectiveness of labour, covering all grades of employees in the enterprise (executives as well as operatives and other staff), by giving due consideration to the physical and psychological factors that underlie organised human activities. Some of the elements with which this responsibility is concerned are outside the province of the foreman—for instance, the task of developing the executive structure of the enterprise or the development of the firm's social policy. But a very large part of the activities of the personnel function

is concerned with the management of the operatives in the factories, and with the conditions in which the work of production is carried out. It is these elements within the personnel function that are included under the title "Labour Management", and in these the foreman has a very considerable part to play. The purpose of this section is to show what duties are covered, and how the foreman can most effectively play his special part. Some idea of the many matters contained in Labour Management can be gained by a study of the chart taken from Tead and Metcalf's "Personnel Administration", set out on pp. 132–133.

The Development of Labour Management and Welfare.

At the outset it will help the foreman to a better understanding of the scope of this function if consideration is given to the historical development that has led up to the present-day position. In point of fact, the emergence of Labour Management as a special section of management in industry may be regarded as the final stage of a long process, stretching back to the early days of industrial development. Broadly speaking, there have been three phases in this growth.

(1) In the first, the main interest was centred on the evil working conditions that came to be associated with the construction and running of factories in certain districts. Parliament was thus compelled to intervene in order to establish by statute minimum standards of physical working conditions, which factory managers and employers had to adopt. The first climax in this process was reached in the Factories and Workshops Act of 1833, when the Factory Inspectorate was established. Gradually during the following forty-five years the legislation affecting working conditions was extended and intensified, and eventually consolidated in the comprehensive Factories and Workshops Act of 1878; this may be regarded as the final point in this first stage of development. (The latest revision of this Act, in 1937, will be referred to in a later paragraph.)

(2) The second phase overlaps the first to some extent, and dates from about the middle of the nineteenth century, when the Trades Unions began to emerge on the basis of specialised crafts or specific industries. It took about

twenty years for the Trades Unions to become established parts of the industrial system, a position acknowledged by the legislation of 1871–1875. With the acceptance of the Trades Unions came recognition of the process of "collective bargaining" as a means of determining the basis on which men and women should be employed in industry. Negotiations between representatives of the workers and representatives of the employers became the accepted technique over large sections of industry in this country for the fixing of hours of work, wages, and other conditions of employment. This process grew from strength to strength, with various supplementary features, reaching the culminating point in the establishment of the Industrial Court under the legislation of 1919. Parallel with it, and as part of the second phase, there was the development of conciliation and arbitration as a means of preventing deadlock resulting from breakdown of the negotiations. A keynote of this period of development was the emphasis on the industrial groupings of workmen as distinct from employers, rather than any particular interest being given to the individual worker as a man or woman personally employed in industry. Another keynote was the emphasis placed on a so-called "conflict of interests" between employers and employed.

(3) The third phase is of a very different character. It began by certain isolated efforts of a few firms in the days before 1914, and went through a period of intense development in the war of 1914–1918. It was a phase in which particular attention was given to the human aspects of industrial life.

The main impetus came from two sources: on the one hand there was certain investigatory work carried out by an official committee called "the Health of Munitions Workers Committee", which was established to study the influence of physical working conditions on output. The Committee began its work in 1915, and was able to produce some very valuable facts in support of limiting hours of work and improving the environment within which production was carried on.

The second source of impetus was the Welfare Department of the Ministry of Munitions, established early in 1916 and concerned to foster the improvement of general conditions

in munitions and other factories. New forces were thus introduced into industry, based upon an entirely different conception of the place of the operator in his shop. In the twenty years that followed, this new view of industrial management speedily gathered strength, and led before long to recognition of Labour Management and Industrial Welfare as essential parts of the organisation and management of factories. The foundation stone of this development was the acceptance of the fact that the operator could carry out his work much more effectively if the conditions with which he was surrounded were of an adequate standard; for instance, that his daily hours of work should be limited, that the spell of each working period should be short or at least interrupted by a rest pause, that the physical factors should be properly attended to—ventilation, heating, position of work-place and bench, etc. It was found by investigation that not only was the operator more content when his conditions of work were of a sufficiently high standard, but also that the output that he was able to achieve was much better and more stable. This latter phase of development has been referred to on many occasions as "giving consideration to the human factor in industry".

Supplementing these three main phases of historical growth there has emerged a fourth, now still in its infancy. This may be regarded as the transition from Labour Management to Personnel Management, in the sense of recognising that other and wider issues than physical conditions are of equally great importance in the management of an enterprise. These other issues are partly psychological and partly matters of broad social policy; their recognition may have very important repercussions on the development of industrial management in the years to come, but they cannot be dealt with in the present context; though it may be said that this final stage of development may well result in considerable changes in the organisation and responsibility of the Personnel or Labour Department.

CHAPTER II

ORGANISATION AND DUTIES OF A LABOUR DEPARTMENT

THERE is at present some confusion of terminology in regard to the personnel function. The expression " Labour Management " has been adopted here simply because this wording is under present conditions the one most commonly found in regular use in industry. Whatever the title, the duties of the executive concerned are in no way different, and his general functions will be very much the same as far as the elements which are under consideration here are concerned—namely, in regard to the particular problems of the management of employment and welfare conditions.

The actual responsibility entrusted to the Labour Manager in different firms will vary considerably. In some firms he will have very much wider scope than he will in others. Again, in some instances he may have a much freer hand to take decisions within his own field, while in some enterprises he may be called upon only to carry out certain duties within closely defined limits or under instructions. These varying conditions mean that the foreman must exercise considerable care when applying his study of Labour Management to the conditions prevailing in the firm with which he is connected. In the description that follows the duties have been based upon the actual practice of a medium sized manufacturing concern, in which the Labour Manager is given a fairly considerable degree of responsibility for the conduct of his function.

From what has been said above, it might appear that Labour Management is only concerned with factories. This is, of course, quite untrue, though it is not generally recognised that all the benefits of specialised management of employment and working conditions in production would accrue equally well in other branches of human activity in business or elsewhere. Since, however, current practice mostly regards the Labour Manager as a functional assistant to the Works Manager or

Production Manager, primarily dealing with the Personnel problems of the factory—which are a main concern of the foreman—this view of Labour Management will be followed here.

1. The Organisation of the Labour Department.

This is largely a question of the size of the enterprise concerned. There is no standard practice. Very small concerns will not have a separate Labour Department or a Labour Manager; and the functions, which nevertheless exist, are performed by other persons. In the smaller factory the Labour Manager may need only one clerical assistant; but in a very large manufacturing concern, especially one having branch factories, there may be a senior Labour Officer with three or four Assistant Labour Managers and a proportionate clerical staff. Many factories include in the Labour organisation a woman supervisor, who is primarily concerned with the particular female problems of the factory in which large numbers of women are employed. Again, in the larger concerns it may be found necessary to have specialised staff for instructing operators, or for carrying out Motion and Time Study work, or for other expert duties which cannot be taken over without special knowledge and training.

Present-day legislation, however, lays down certain definite obligations which have to be carried out, *e.g.* :—

(*a*) In all cases in which Emergency Orders are made under Section 150 of the Factories Act or Defence Regulations 59 which allow the employment of women on a night shift, the following condition is included in the Order—"suitable arrangements shall be made for the supervision by a forewoman or welfare supervisor of women employed in the night shift."

(*b*) In July 1940 the Factories (Medical and Welfare Services) Order was made. This provides that the Chief Inspector of Factories may direct any factory in which is carried on the manufacture or repair of any munitions of war or any work on behalf of the Crown to make arrangements to the satisfaction of the Inspector for the employment of Supervisory Officers for the supervision of the welfare of the persons employed in the factories.

Briefly, the position may be summarised by saying that wherever conditions allow, the personnel function needs a responsible Labour Manager, whose job it is to see that the requirements of his function are properly met, plus the necessary assistant staff to carry out the specialised duties that fall within his Department's province and the general clerical duties that are necessarily entailed by the work of his Department.

The duties of a Labour Department may be broken down into the following main groups :—Employment management, selection and engagement of new employees, introduction of new employees to work, training, upgrading and promotion, termination of employment, industrial welfare including health and safety, social amenities.

2. Employment Management.

This would be carried out with the co-operation of the works manager and the foremen, and would cover :—

(*a*) determining hours and other conditions of work, conduct, and behaviour, including the internal rules and regulations, hours of work and rates of pay, in the factory, but subject to legislation and to any external regulations and agreements in force from time to time;

(*b*) all activities concerned with the recruitment, training, and progress of the employees;

(*c*) close liaison with other departments.

To this group of functional activities is added the maintenance of employee records—of great importance, especially in war-time conditions, when records are necessary in regard to such items as National Service registration. Such records are also the basis upon which the progress of an individual operator can be considered at various stages in the course of his employment with the enterprise; and again they are the basis of assessing the improvement of conditions in the factory by the reduction of labour turnover, control of absenteeism, etc.

3. The New Employee.

(*a*) *Selection and Engagement.* No doubt the foreman could engage his own operators, but the Labour Manager will bring to bear on that task more specialised knowledge of human

beings and wider experience in handling men and women of different types and characters. He will also have a more comprehensive view of the factory as a whole, and be far better placed to note the trends of employment in different departments, as well as the varying types of individuals required in different jobs, and other similar factors.

Within the last few years a great deal of research work has been carried out in connection with the psychological aspects of vocational training and suitability for particular grades of employment. The Labour Manager is able to study these techniques, and arrange for the assistance of expert investigators to help him solve special problems of training personnel for particular jobs. It is surprising how many operations can be simplified, although they have been standardised in the factory for years. The foreman should always be ready to co-operate in such development, since he will realise that the Labour Manager can more accurately assess the types of individuals required to fill particular jobs, and will also have more time to devote to the task of finding the right operator for the particular vacancy at hand. It is, in fact, just another illustration of bringing to bear the principle of specialised skill in the performance of a certain task, and clearly a far more satisfactory result can be expected.

(*b*) *Introduction to Work.* In the days when the foreman engaged and dismissed his own labour he was only able to pick his men or women, go through the necessary preliminary formalities, and then put them on the job with a brief introduction to their place of work and their mates. But under a properly managed Labour Department, introduction of the new employee is made a matter of great seriousness, comparable to the greater expert attention given to selection. A new employee is made to feel that his or her arrival is of some significance to the firm, as well as to the individual himself. He is accordingly interviewed on his first day before he goes down to his shop. He is given some general information about the firm and its departments, about the amenities that the firm provides, such as rest pauses, canteens, cloak-rooms, and so on. He is shown where the various places are to which he will need at times to go. He is properly introduced to his department, to his foreman and charge-hand, and to those men and women with whom he will have immediate association. Later in the

day or later in the week he will again be interviewed, in order to see that he has properly settled down and that any queries which may have arisen can be effectively answered. In other words, he is given a real introduction to the place in which he has chosen to work. All this naturally ties in very closely with the period of training which has been laid down as the minimum required to fit him or her into the organisation. It is just as necessary in the smaller factory as in the very large concern, and the close co-operation of the foreman is essential to ensure success in this as in all other phases of Labour Management.

(c) *Training.* This may deal broadly with three main groups: Apprentices, Trainees, and Operators.

If the organisation is to provide for healthy development, these groups must be considered from the standpoint of both long-term and short-term policy. A brief survey will be made of each group, although the foreman may be chiefly concerned with the last group, since maximum production depends on his effective working force. He should co-operate in dealing with, and take an intelligent interest in, the other two. He is apt to overlook them because he did not have the benefit of such facilities during the early days of his own career.

Young trainees may be recruited at the age of 16, and a carefully selected number of them will follow a course of apprenticeship training in the factory, which lays down certain periods of time to be spent in the respective departments. During this course they are released usually for one day or two half-days per week to attend the local Technical College, and thus proceed with their technical training alongside the works training. This group provides the training for Design Staff, Production Departments, and Supervisors, and in its later stages should include a study of leadership and management method.

The second group consists mainly of young trainees selected to follow particular trades, or to be attached to one department only when their course is complete. A few of these may attend classes of a specialised nature, but the bulk of them will receive the whole of their training in the works and its works school or training section. Transfer may take place to the previous group.

The third group covers adult labour, and is by far the largest group. Technical training usually does not appeal to them,

but it is important that they be taught the operational methods in use throughout the department of the factory to which they will be attached. Social activities appeal most to this group.

Usually a committee of foremen is consulted on long-term training policies, and consequently the modern foreman should make himself familiar with the trend of present-day educational facilities, which have developed rapidly in late years to meet industrial needs.

As the operator group is so important and of a short-term character, the foreman's active contribution to training would be primarily concerned with the training and retraining of operators for their jobs.

One of the special features in the development of the past twenty years has been the greater emphasis placed on the importance of initial training when a new employee is brought on to a job. It has been recognised that a good deal of production time can be saved, and certainly damage to expensive equipment can be avoided, by careful training. At the same time the operator can be provided with the means of earning higher bonuses if he or she is properly trained in the best way of performing the job. In some of the larger factories the importance of operator training has been so effectively recognised that special staff have been engaged as instructors.

There is danger under war-time conditions of neglecting training in the supposed interests of speeding up production. Men or women are engaged from Government Training Centres and, after a very brief introduction to their jobs, are regarded as ready for the full-steam-ahead order. But a certain amount of further initial expenditure of time might be well worth while, because the operator who is *properly trained* for the job, when he or she takes over, will necessarily turn out a much more satisfactory operator, and in the long run will more than make up the days or weeks that might have been considered "lost" in the extra training. Every foreman should give particular consideration to this point, and never agree to a shortening of the training period unless he is definitely convinced that the individual concerned is really of the required standard.

Another important element in operator training is the process that has come to be known as Motion Study. This means an analysed study of the movements required in the performance of a job, plus a similar study of the conditions surrounding these

movements—*i.e.*, of the posture of the body in relation to the machine or bench, of the layout of work, of the flow of materials, and so on. The purpose of motion study is to ensure that no energy is wasted in any direction, and at the same time to secure the best arrangements of working conditions and lay-out in the interests of high output. It has too often been thought that motion study is concerned simply to turn the operator into a part of the machine—into an "automaton", as it is usually put. This is a complete misconception of the real meaning of motion study; the primary consideration of those who have developed this science is to improve the conditions surrounding the operator so that he or she is saved from wasting time and effort through having to reach for tools or materials which are left haphazardly in awkward places. The purpose is to make it possible for the individual worker to attain a higher level of output with a lower net expenditure of energy.

Foremen cannot be expected to go in detail into the science of motion study, but they should certainly be expected to have a general understanding of what it means and how it is applied.

Another element which might well be considered as part of the duties of the Labour Department under this heading of training is the development of day continuation education for younger employees. To a large extent this is a matter of social policy, but it is important for the foreman to realise that a firm which embarks on a policy of day continuation education for its juvenile employees up to the age of 16 or 18 is, in fact, undertaking a task which is not only of considerable advantage to the community, but also of direct benefit to itself. Boys and girls who leave school at the age of 14 are still immature and under developed, and the extra learning and ripening that they receive from a full day applied to further schooling between the ages of 14 and 18 can be of considerable benefit to the firms employing them.

The Government, through the Ministry of Labour, has instituted various training schemes such as the Government Training Centres giving intensive courses to train men to the improver stage in the various branches of engineering work, courses at Technical Colleges for upgrading and advanced training and, more recently, the Foremanship Training course. Full details of these training schemes may be obtained from Labour Exchanges.

4. Upgrading and Promotion.

In no way is it easier to damage morale than by absence of policy in regard to upgrading and promotion. In a firm where the supervisory and similar staff positions are constantly being filled from outside, without any opportunity of promotion being given to existing employees, the good men and women will feel neglected and slighted, deliberately prevented from making headway. They will almost inevitably lose interest in the firm, and consequently in their work, and the natural result will be a keen desire to get out; or, if the circumstances are such as to make employment there desirable on extraneous grounds, there will be lack of interest and slackness at work. On the contrary, those firms that make it a matter of policy to give existing employees first consideration for higher appointments keep a material sense of interest among their employees. There is in the human being an almost instinctive desire to make progress; it is not always evident in large sections of the community, but if suitable conditions are provided these instinctive forces will soon become apparent. The institution and operation of a policy which satisfies that instinct are in fact two of the most valuable features that a functional Labour Department can contribute to the stability and progress of an enterprise.

5. Termination of Employment.

In normal times this is often a very thorny problem when the Labour Deparment is first established. In many factories without a Labour Department the right of terminating employment rests with the foreman or supervisor of the shop; but when a Labour executive is introduced, the final responsibility for terminating employment is left with the Labour Department, and not with the shop foremen or supervisors, though they must obviously retain the right to recommend dismissal. For this attitude there is strong justification, and its value is shown by the major results achieved. First and foremost is the fact that an objective tribunal for dismissals is established. This is not in any way to suggest that a foreman would not be an impartial judge, or that he would wield his right of dismissal unfairly. But in the very nature of things a foreman is, as it were, prosecutor and judge in one, if he carries the authority for dismissal. The operator concerned

has no court of appeal at all, and feels that any action that he might take would impair the position of the foreman in his shop. But if the right of dismissal rests with the Labour executive, the case is handled by an objective judge to whom the prosecutor can address his evidence; and at the same time, without in any way causing a face-to-face conflict between foreman and operator, the latter is given a fair and unbiased opportunity of stating his own case. The greatest gain is the sense of fairness that operators come to perceive. The individual knows that his or her point of view will be considered, and the whole process of dismissal is elevated to a much more satisfactory level. The dismissal of an operator should be a matter of very serious concern, not one that can be just lightly entertained. All the more reason for making it a matter that is handled by a senior officer of the enterprise. The final gain to the factory is once more in the sense of contentment and ease of mind that the operator enjoys, and the reflection that this has upon his or her ability to work.

At first glance, the foreman might consider this a process that undermines his authority. The right to sack, he might say, is the foundation of his control over his men and women. This is a standpoint that needs careful examination—but one which because it is fundamentally weak will not stand up to any such scrutiny. If the foreman's case for dismissal is sound, the Labour Manager will obviously support it whole-heartedly. But if the foreman's case is unsound, then nothing in the name of justice can support it. In the management of industry today, the foreman's authority must rest on something stronger and better than the "right to sack". Under the Essential Work (General Provision) Order, 1941, if the Minister of Labour certifies a given undertaking to be a Scheduled Undertaking, the employer therein may not discharge any person to whom the certificate applies (except for a serious offence) without the permission of a National Service Officer, and without giving at least one week's notice.

6. Industrial Welfare and Social Amenities.

Broadly speaking, this section covers the control of the physical conditions under which the work of the factory is carried on. As was shown in an earlier paragraph, certain minimum standards have been set up by the State. The Factories Acts

are now over one hundred years old, having at intervals been modernised and brought up to date. The latest Act was passed by Parliament in 1937, and carried the minimum standards in regard to conditions of employment in factories to considerably higher levels than any previous legislation within this field. It should be read and studied carefully.

The Labour Manager has to have a considerable knowledge of the requirements of the Factories Act, and also of the subsidiary regulations made under the authority of that Act. He is responsible for seeing that in the factory under his care the requirements of legislation are carried out. The foreman himself need have no great knowledge of the legislation, but he has certainly a large part to play in co-operating with the Labour Manager in ensuring that the required conditions are properly maintained.

In addition to the minimum standards demanded by legislation, there has been in recent years considerable development in the field of industrial health, welfare, and safety. It is by now generally accepted that the physical conditions of work are important factors in maintaining the effectiveness of a production department or shop. To a very large extent this fact is quite an obvious one, known to all of us from everyday experience. It must be quite clear that unsatisfactory temperature of a workroom, with bad air conditions produced by inadequate ventilation, the presence of dust and fumes, and other adverse conditions, will react adversely on one's ability to work. In the same way we know that continuous work at even moderate speed produces fatigue, more especially if it is carried out standing and entails numerous bodily movements. It has been proved time and time again that the introduction of a rest pause in the course of a work spell is a powerful corrective to the accumulation of fatigue, and enables operators to keep up a much more effective level of output throughout the shift. Indeed, it has been proved that there is a special point at which the rest pause should be introduced, determined largely by the nature of the operations and the speed by which fatigue is induced; but from the foreman's point of view it is sufficient to stress the fact that the introduction of a rest pause during a four or five hours' work spell will have good effects upon the maintenance of output. In just the same way the foreman must be expected to understand the extent

to which the physical conditions in his shop affect the ability of his operators to keep up a good working level.

The question of the health of operators is one to which even now insufficient attention is given. The problem of absenteeism can often be found linked up with a poor standard of health in the operators concerned. Quite a number of firms have found by definite experience that the appointment of a works doctor to look after the health of the employees has meant the saving of hundreds of hours of working time and immense sums of money through safe-guarding output. The modern Labour Department undertakes the responsibility for the care of the health and physical welfare of operators. It should obtain on engagement particulars of the individual's health record, and if possible have a man or woman medically examined in cases of doubt. A large enterprise can afford to maintain a medical specialist or to have working arrangements with a local doctor in order to have someone to whom to refer employees who are apparently ailing or otherwise in need of medical attention.

Apart from the direct benefit which the factory will gain from the attention given to this question of physical conditions of work and their effects on health, there is a further and less direct benefit—namely, the advantage derived from a greater sense of contentment experienced by the employees themselves, because they feel that they are being cared for as individuals, and that the management is interested in their welfare and well-being.

In this general group of responsibilities there comes also the question of safety, or accident prevention, a matter which is to a large extent determined by the provisions of the Factories Act. In addition, the Labour Manager will find ways and means of developing a safety sense in the works under his care. The majority of serious accidents in factories are avoidable, and the suffering caused to the individuals and families concerned could be obviated by the application of a small degree of reasonable care. In this direction the Labour Manager has a very important task to undertake, and the foreman has an equally important part to play in enabling this task to be carried out effectively.

The group of duties of the Labour Department covered by the title Industrial Welfare, including health and safety, may be

broadly summarised as providing an environment in which operators can carry out their work in the most comfortable surroundings that are practically possible.

There are some further duties of the Labour Department in this group which may be considered as supplementary, but not as unnecessary or unimportant. They have, in fact, become gradually recognised in the course of recent years as being of almost equal importance with the industrial welfare developments now looked upon as natural or commonplace. Among these amenities the most regularly provided are canteens. War-time conditions have made the importance of the canteen at the works very much greater, and one of the recent regulations of the Ministry of Labour has empowered the Factory Inspectors to demand the establishment of a canteen in a factory if they feel that conditions are such as to warrant it. War-time conditions have also necessitated the provision of other amenities, such, for instance, as facilities for transport to and from work.

In certain firms there are even specialised developments such as family allowances, or pensions schemes. On the other hand, quite a large number of firms have for long years maintained sports grounds and other recreational facilities for their employees.

The point about all these activities of a social character is that they are considered as serving to enhance the interest of the individual employee in the firm, and to develop in him or her a greater sense of loyalty and attachment to the enterprise. They thus serve to increase contentment in work, and so to promote stability in the general labour force. The biggest part that the foreman has to play in this connection lies in the attitude that he adopts towards them. To the extent that the foreman is aware of the value of the social amenities provided by his firm, and lets the operators under his jurisdiction know that he is aware of their value, he will be playing an effective part in helping the Labour Department to carry out the tasks entrusted to it.

* * * * *

The above paragraphs have given only a very general and summarised review of the main activities that fall within the responsibility of the Labour Department from the point of view of Labour Management and Welfare. It will readily be seen that at every turn these duties can be effectively carried out

by the Department only through and with the co-operation of the foremen in the shops. The Labour executive must bring to bear a specialised knowledge and experience in determining the policy that underlies these duties and in framing the lines along which they will be carried out; but, however expert and sincere his work, he cannot make it properly effective unless he can count upon the whole-hearted co-operation of the foremen in the factory; and the foremen themselves are unable to give this whole-hearted co-operation unless they understand what Labour Management and Welfare mean, and realise the value of the contribution thus made to effective management.

THE FUNCTIONS OF A CENTRALISED LABOUR

Supply of Personnel.

Sub-divided

Employment.

1. Knowledge of:
   Law.
   Contract of Service.
   Factory Act.
   Health Insurance Act.
   Unemployment Insurance Act.
   Truck Act.
   Sources of Supply.
   Workroom Jobs.
   Wages Rates paid:
   (Trade Unions.)
   (Trade Boards: Employers.)
   Hours of Work and other Terms of Employment.

2. Selection:
   Preliminary Interview.
   Interview.
   Engaging.
   Follow-up of References.
   Physical Examination.
   Intelligence and Trade Tests.
   Other Special Tests.

3. Introduction to Works:
   General Instructions on Company Policies.

4. Follow-up of New Employees.

5. Recommendations for Transfers and Promotions.

6. Interviewing all Leaving Employees:
   To ensure fair treatment.
   To discover reasons for leaving.
   To analyse discharges.
   Labour Turnover.

7. Compilation and Care of Records:
   Applicants.
   New Employees.
   Adequate Individual Progress Records.
   Good and Bad Records.
   Promotion, etc.

8. King's Roll:
   Fair Wage Clause.

9. Co-operation with Outside Agencies:
   Employment Committees.
   Court of Assessors.
   Court of Referees.

Health and Safety.

1. Knowledge of:
   Factory Act, etc.
   Public Health Act.
   Workmen's Compensation Act.

2. Recommending Standards of Physical Fitness for Worker at Different Jobs.

3. Physical Examination of:
   Applicants.
   Present Employees.
   Re-examination of Defectives.
   Special Oversight over Workers exposed to Industrial Hazards.

4. First Aid:
   Ambulance Room.
   Works Surgery.

5. Treatment of:
   Surgical and Accident Cases.
   Dental Cases.
   Ocular Cases.
   Medical Cases.

6. Individual Medical Advice:
   Home Service.

7. Systematic Plant Inspection by:
   Safety Officers.
   Safety Committees.

8. Co-operation with Proper Authorities in Reporting all Accidents.

9. Accident Control and Reduction:
   Following best Building Practice.
   Guarding of Hazards.
   Safety Organisation and Education.
   Follow-up of Accidents.

10. Compensation Payments.

11. Prevention and Elimination of:
    Communicable Diseases.
    Epidemics.
    Industrial Disease Hazards.
    Special Strains of Industry:
    Fatigue.
    Mental Strain.
    Motion Study.
    Working Hours.
    Rest Periods.
    Problems of Women's Work.
    Juvenile Work.

12. Systematic Check-up of all Working Conditions:
    Sanitation.
    Cleaning.
    Ventilation and Humidity.
    Lighting.
    Heating.
    Washing and Bathing Facilities.
    Toilet Equipment.
    Cloak Rooms.
    Lockers.
    Drinking Water.

13. Co-operation in Study and Investigation of Absence.

14. Fire Hazards.

15. Occupational Hazards.

16. Adequate Records and Statistics on all Health Matters:
    Physical Examinations.
    Sickness Treatments.
    Accidents.
    Occupational Diseases.

This chart covers all possible functions of a Labour Department.
Reproduced from "Personnel Administration" (Tead and Metcalf)

(PERSONNEL, EMPLOYMENT, WELFARE) DEPARTMENT

CONDITIONS SURROUNDING PERSONNEL

INTO

EDUCATION.	RESEARCH.	EMPLOYEES' SERVICE.	EMPLOYEES' REPRESENTATION.
1. Training Executives.	1. Legislation affecting Industry.	1. Recreation: Noonday and Rest Period. Programmes. Co-operation and Supervision of: Athletics. Sports. Dramatics. Musical Clubs, etc.	1. Grievances and Complaints.
2. Training Supervisors. (Foremen and Forewomen.) Instructors.	2. Knowledge of: Job Analysis. JobSpecifications. Time and Motion Studies. Fatigue Studies.	2. Sickness Benefit. Clubs and Insurance Schemes.	2. Co-operation in: Drawing up Works Rules. Adoption of and carrying out Works Rules.
3. Training New Workers in: Company's Policy. Knowledge of Company's Product. Accident Prevention.	3. Wage Rate Studies and Recommendations. Bonus Systems, etc.	3. Co-operative Purchasing Arrangements.	3. Adjusting Questions of Discharge. Appeal against Dismissal.
4. Apprentice Courses.	4. Studies of Cost of Living.	4. Rest Rooms.	4. Co-operation in: Supervision of Works Committees. Joint Committees. ·Club Committees: Sports. Savings. Sick. Trustees.
5. Initiation Schools.	5. Perpetual Labour Audit of the Factory.	5. Summer Vacations.	5. Conferring with the Shop Steward or Trade Union Representative on Terms of Employment.
6. Part-time Continuation Schools.	5. Study of Current Labour Experiments with Recommendations as to their Adaptability.	6. Lunch Rooms.	
7. Job Instruction.		7. Gardens at the Works for the use of Employees. Sports Grounds	
8. Company's Publications.		8. Supervision of Company Housing.	
9. Suggestion System.		9. Savings Activities.	
10. Bulletin and Notice Boards.		10. Co-operation in Maintenance of: Adequate Local Housing. Transportation. Public Health. Primary Education. Other Civic Activities.	
11. Circulation of Magazines. Library of Educational Books.		11. Legal Aid.	
12. Organisation of Educational Clubs.		12. Loans.	
13. Training for: Transfers. Promotions.		13. Superannuation: Pension Schemes.	
14. Training in: Personal Hygiene. Safety.		14. Profit - Sharing Schemes.	
15. Co-operation with Outside Educational Agencies.		15. Co-partnership.	

Probably no firm includes them all, but each one is carried out somewhere.
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CHAPTER III

THE HUMAN FACTOR

Comparing the development of industrial relations in the earlier phases of our industrial history with that of the past twenty years, it will be found that the main difference lies in the *attitude* of management or employers towards the men and women working in their factories. In earlier periods (say, for instance, in the very progressive years of the latter part of the nineteenth century) the emphasis was on groups—*i.e.*, employers on the one side and operatives on the other—each group having certain interests of their own that they were primarily concerned to maintain. During the course of the past twenty years the emphasis has been far more on the individuals in the enterprise—*i.e.*, on the managers and employees as men and women doing a certain job of work. In part this difference may have been due to the large extent to which management is now in the hands of salaried officials as compared with fifty years ago, when management was the employer—*i.e.*, the owner of the business. But whatever the cause for the change of view, the fact itself is of prime importance. It is closely linked with all the development already referred to in the field of industrial welfare and labour management generally. We are now primarily concerned with men and women in factories regarded as individual human beings engaged on certain work, a point of view that does not in any way detract from the solidarity of the Trade Union movement. This different attitude represents what has been called by one writer a new " Philosophy of Management ".

The organisation of industry covers, as has been pointed out in earlier paragraphs, a combination of men, materials, and machines. Hitherto particular regard has been paid to the maintenance and control of the latter two of these factors of production; in fact, the development of management has been a story of gradually improving technique of control over the materials and machines used in the manufacture of goods.

And this new conception of employment in industry is the completion of that progress by giving the same scientific consideration to the human factor. The big danger is that of becoming sentimental in this connection. It is the danger of thinking only in terms of "promoting the well-being of the workers". Throughout all the preceding paragraphs particular emphasis has been laid upon the fact that a high standard of management in the Labour function is a necessary adjunct to the scientific management of the factory itself. The point has been stressed that effective control of the human factor in industry represents a sincere contribution to effective management in industry—represents, in fact, an indispensable element in it. One might even go so far as to say that many of the industrial difficulties of bygone decades have been due to all the emphasis in control being placed on the material and mechanical elements, and the human element being neglected—left to jog along as best it could. But in the past twenty years there have been valuable lessons. Investigations and experiments that have been conscientiously conducted by expert organisations keenly interested in the effective management of industry, through the effective control of the personnel aspects, have brought to light the significance that attaches to such things, for instance, as the maintenance of proper physical working conditions, the installation of really satisfactory lighting, the provision of social and personal amenities of various kinds. Above all else, however, these investigations and experience have proved the undoubted value of the different attitude of management towards the persons whom it controls—an attitude of mind in which such persons are seen more as collaborators and co-operators with certain tasks to perform, rather than just as hands whose energy is hired for a certain wage and who can be disposed of at will. Perhaps no lesson has been more clearly taught in these twenty years than that which indicates the benefit to the progress of production and growth of the enterprise which flows from a stable and settled labour position; and a stable labour position can only be obtained in an enterprise where the human factor is given adequate consideration.

Seen in this way, Labour Management and Welfare is shorn of the danger of degenerating into sentimentalism, and takes its proper place as a necessary function in a scientific system of

general and departmental management, contributing equally with other functions of management to the improvement of production, the economy of operation, and the effectiveness of control.

In the course of the developments which have taken place in the past twenty years perhaps rather too much emphasis has been placed on the " welfare " aspect of Labour Management. The word itself is no doubt a little unfortunate, because of its association in other directions—it has, in fact, been defined in one quarter as " being consciously preoccupied with one's neighbour's affairs ". To some extent the whole progress of Labour Management has earned the contempt of the so-called practical industrialists because of this preponderant influence of the welfare elements, or rather because of the predominating influence of the less important and less realistic welfare elements. But the paternal attitude towards employees which is associated with these welfare aspects is not in any sense a requirement of Labour Management. On the contrary, it might perhaps be better avoided or minimised. What is rightly to be understood by " giving proper consideration to the human factor in industry " is a difference in attitude towards employees which may be illustrated by giving due consideration to their suggestions and complaints.

A most valuable feature in the strengthening of the morale of the factory is the opportunity given for voicing opinions, especially for voicing criticisms and grumbles. The strengthening of morale is made even greater if means exist not only for employees to voice their criticisms and grumbles, but also for proper consideration to be given, and for remedial steps to be taken or a suitable explanation offered. Similarly, if employees are made to feel that their suggestions or ideas are welcomed, they will have a greater sense of interest in their work and in the firm. A body of men and women who are day by day employed in going through certain processes represents a large and cumulative force of human thought and ideas. Much of this can possibly be of considerable value to the enterprise; but at any rate a firm that encourages its employees to put up their suggestions, to contribute their ideas, to voice their opinions, however critical, is so much the more realistically confirming the fact that it regards its employees definitely as individual men and women with minds of their own, with individual

viewpoints, with different things to say that management should hear and attend to. The detailed process by which a suggestion scheme or complaint scheme is worked is of no particular significance in this context; but the principle of admitting expression of opinion as a contribution to management is of the greatest importance, and is one of the most practical ways in which real consideration can be given to the human factor in industry. Here, too, the goodwill and practical help of the foreman are of the first importance.

CHAPTER IV

THE FOREMAN'S CONTRIBUTION TO A SOUND LABOUR POLICY

THE main effect of a sound labour policy will be to attain a very much greater degree of labour stability. It has been proved time and time again in firms of very different character that the establishment of a Labour Department under a responsible Labour Manager leads to a steady decrease of labour turnover; in other words, labour stability should be a natural outcome of the labour function. Now, labour stability is of importance to any factory. Losses incurred by a high labour turnover are obviously considerable—operators constantly leaving and having to be replaced mean loss of time in re-training, also a high proportion of trainees to skilled operators, with consequent wasting of material and possible damage to machines, tools, etc. To the foreman himself high labour turnover means vexatious problems and an unstable shop. Thus the successful establishment of a Labour Department, and the increase of stability in the factory that will accompany it, are factors of the utmost importance.

By the establishment of its Labour Management and Welfare function, management recognises the dignity and high importance of the human factor. But that in itself is not enough. The foreman is the point at which management is interpreted to the employees, he is the first arch in the bridge that leads from operation to the highest point of control. It has already been said that however good the policy of management, it can be rendered ineffective by weakness in supervision. This is more true in regard to the Labour function than in regard to any other point in management. In the controlling of production, weakness of supervision can be partially countered by the methods and documents that form the system. But in the management of the men and women in the factory, weakness or neglect in supervision cannot be countered by anything at all. In short, unless the foremen understand and admit the signifi-

cance of giving consideration to the human factor in industry, the most enlightened attitude of management in this direction will fail of its real purpose. Put into other terms, it might be said that the key to the success of a sound policy of Labour Management and Welfare is the extent to which the foremen in the enterprise accept this function and whole-heartedly co-operate in putting it into effect.

SECTION IV

COSTING AND REMUNERATION

CHAPTER I

COSTING

1. Objects.

The objects of costing may be summarised as :—

1. To account promptly, fully, and accurately for expense of all kinds.

2. To find the Factory Oncost (*i.e.*, normal expenses other than labour and material directly used in production) attributable to each Production Shop, and to recover it by an appropriate charge on each product whereon work is done in that shop.

3. To find the total factory cost of each article made or job done in the factory for sale.

4. To find the cost of capital additions.

5. To find the amounts of special expenses, such as development, experiment and research, errors and defects, war cost and damage.

6. To detect waste and to indicate possible economies.

7. To facilitate the comparison of actual with estimated costs.

8. To explain the profit or loss on the working of the factory as such.

9. To find the amounts of all administration and selling expenses.

10. By all these means to give to the higher management the information necessary to enable them to arrive at selling prices of the Company's products, and to conduct its administration with full knowledge and effect.

2. Costing as an Aid to Management.

Every foreman should ask himself the following question : " If I owned the shop in which I am working, what is the first thing I would want to know about it ? " Surely the answer in ninety-nine cases out of a hundred would be : " How much is the work in the shop costing me ? If I do not know that, how can I tell whether the orders I have undertaken will

involve me in a loss instead of the profit I anticipated when accepting the work?" In other words, he would wish to control money spent as against money received. The failure of a firm may result from a number of causes, but obviously a firm cannot, in the long run, continue to operate if the cost of the goods produced exceeds the price for which they have been sold. It is, in fact, vital to know exactly the cost of all products sold. This is evident under the highly competitive conditions of commerce, but a close cost scrutiny is no less important under war conditions.

When a foreman thus extends his view and interest in the shop, he is at once struck by the number and diversity of expense items which have to be paid for, and he will feel concern, not only as to whether all the expenses can be met, but also whether each and every job, to perform which these expenses were incurred, is not costing more than was estimated or allowed.

He will ask how he can be assured that all the expenses are being collected together, that the information is accurate, and that each order, job, process, or operation in the shop is being correctly costed.*

He will arrive at the conclusion that some system must be devised to provide expeditiously the correct costs of work, and he will further perceive that this ascertainment of costs is not an end in itself, but provides a means by which costs may be controlled in time. It is of no use knowing that costs are too high when it is too late to do anything about it.

The foreman will thus understand and appreciate the point of view of the management, whose job it is to obtain maximum results with minimum expenditure—or at least to keep within estimated expenditure—and who must obtain prompt and reliable cost information in order to control production and ensure profitable working, which is the root of all the activities of a firm.

Efficient production involves making the best use of materials, labour, plant and equipment, and the various factory services which are an aid to production. The costs of all these have to be recorded promptly, and the facts set out with simplicity and accuracy in time for the management to take the requisite executive action in relation to what the costs ought to have been.

* The chart "Fundamentals of Costing" (Fig. 29, pp. 152–153) is well worth study.

The management cannot judge the efficiency of production without a reference point on standard of cost. For this purpose a cost standard should be established where practicable. It is most practicable in the case of continuous production or repetition work. In job or small batch production the point of reference can only be the estimate based on experience.

The foreman will perceive that the compilation of correct costs directs the attention of the management to sources of waste and leakage, to uneconomic expenses, to unprofitable lines of work, to shops, sections, machines, or men which are in need of improvement. Inefficient labour is very expensive, wasting money and disorganising production; cheap raw material may be a poor investment. Cost records reveal these points and keep a check on expenses of all kinds, showing the management the degree of efficiency with which material and labour are being used, and how economically the attendant services in the works are being employed. Moreover, cost figures have a future use—viz., they provide data for future estimating purposes.

Costing technique is not, in fact, limited to finding costs; it also assists in the accurate forecasting of costs, which is so necessary for executive decisions.

As a manufacturer wishes to judge the future as well as to know the past, present-day management is tending to the use of cost statistics to reveal the trend or tendencies of the business.

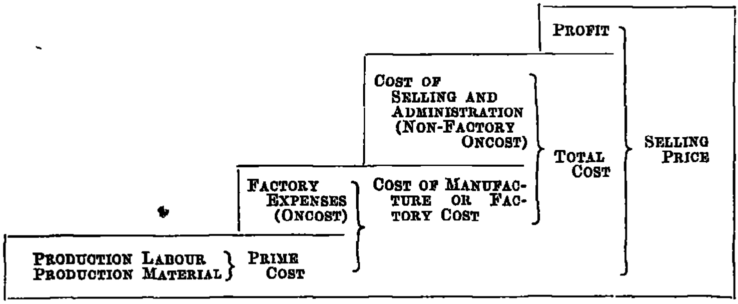
Costing not only assists the management to reduce service expenditure to a reasonable minimum and to direct positive expenditure into the right channels, but also provides the firm's executive with a guide as to general policy.

Another costing technique with which the foreman should be acquainted is budgetary control, or budgeting in advance what the costs should be, and providing means to bring to the attention of the management any divergencies from the anticipated costs.

3. How a Cost is Constructed.

A foreman's practical experience will relate to costs involved in production; but the total cost involved in running a manufacturing firm includes costs arising in the factory, in selling the products, and in administration of the firm. The total cost or expenditure of the concern must therefore be classified under groups corresponding to its activities. The

elements of total cost, which must be recovered in the selling price, may be set out in simple diagrammatic form as follows:



or in slightly greater detail in the following alternative presentation:

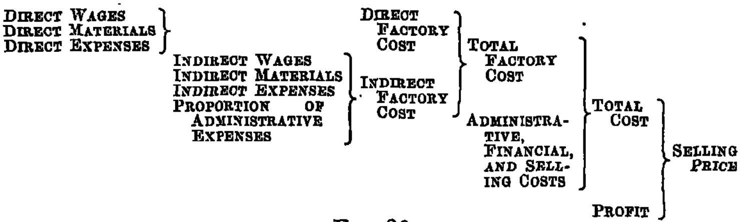


FIG. 26.

The direct cost consists of those charges which are incurred on a particular job or product, and may therefore be charged to that product directly. These include the material which appears in the finished product, the wages of production labour, and any expense incurred specifically in connection with that particular product.

Indirect costs are those charges which are incurred on several jobs or products. It is generally convenient to assess the proportion of such charges which each product should bear. As far as possible they are grouped in classes to secure accuracy, and charged to the products on a basis determined by careful investigation.

They include the cost of materials which do not appear in the final product, such as workshop supplies (*e.g.*, oils, cleaning-waste, small tools, and fuel) and the wages of auxiliary labour, such as cleaners, transport men, storekeepers, inspectors, time clerks, firemen, night watchers, etc. Other indirect charges are rent, rates, and other factory expenses, such as the cost of supervision, building expense, plant expense, and cost of power,

heating, water, and insurance; and it is useful to keep a miscellaneous heading for such items as employers' liability charges, works stationery, maintenance, etc.

In the above table a heading has been included for a proportion of administrative expenses to cover the services rendered to the works by the cost department, welfare department, research department, planning department, and so on.

When all the above charges involved in running the works have been accumulated and added to the prime cost, the factory cost is obtained.

Costing does not stop with setting down the total expense of production; it analyses the cost of the other functions of the business—advertising, selling and marketing, and administration of the business. These charges are called general or administrative overhead expenses, and when they are added to the factory cost the total cost is obtained.

Costing methods must be adapted to manufacturing procedure, and various methods of recording costs have been evolved to fit in with production requirements.

Job costing applies to any job or contract which is kept separate from other production during manufacture.

Process costing applies to products which are put into production in large numbers and where it is neither convenient nor economic to take out costs for a single article.

Multiple costing refers to the bringing together of various costing methods—*e.g.*, job costing, process costing, assembly costing—where this is necessary to obtain final costs.

Operation costing is actually the breaking down of job costing to separate operations on a component.

4. Cost Data.

A fuller consideration of the cost data which have to be recorded in order to ascertain works cost may be started from consideration of a simple cost sheet.

Operation.	Time taken.	Rate.	Time wages.	Premium.	Labour cost.	Material cost.	Overhead Expense.		Factory cost.
							Departmental.	Factory General.	

FIG. 27.

For the control of direct labour cost an efficient system of time accounting is necessary, which, as the foreman knows, is usually carried out by the workmen clocking on and off job-cards—one for each job. The time spent on every operation is converted into money by the wages clerk, according to the system of wage payment employed in the works. The production wages earned are transferred to the job cost sheet.

Material cost must be accurately recorded. This can only be done by an efficient system of stores control involving the following procedure :—

(1) All issues must be against a duly authorised requisition stating the job number or production order so that it can be readily traced on the stock card.

(2) Material returned to store, whether issued in excess or due to rejection, must not be accepted without a credit note giving particulars, which is passed on to the cost department.

The quantity of material used on the job is priced and the cost entered on the job cost sheet. This relates to material in stock. For materials purchased for the job the cost is obtained from invoices; if partly processed material is used, the cost up to stage at which it enters the shop in question is employed.

Overhead expenses, or oncosts, are those expenses which cannot be charged to a particular product or job; they are therefore grouped into classes and apportioned on some suitable base to the product or job. They are divided, as in the specimen cost sheet, into those that can be charged to the department and those which arise in the general administration of the firm.

As regards the charges on the manufacturing or production departments, these include the use made of the service departments (stores, inspection, drawing office, tool room, time office, and maintenance department). The cost of running these service departments includes electricity, gas, coal or coke, stationery, staff, etc., and these expenses are detailed and summarised. The total cost of each service department is then shared or spread over the manufacturing departments, according to experience. For example, Production Department "A" may make four times the use of the drawing office that Department "B" does, but only half the use of the

Stores organisation. By going carefully into the actual expenses in detail and noting where they arise, the cost accountant is able to apportion to each production department its fair or proper share, and express the result as a simple calculation based on the time a job is worked on in the shop, so that this column in the cost sheet can be quickly filled in.

The column relating to general factory overhead may be based, for example, on a simple proportion or percentage of the labour cost, worked out by the accountant from the actual figures over a suitable period of time, to cover the shops' appropriate share of the general factory administration and other expenses, or such proportion may be ascertained more satisfactorily on a machine-hour or on a man-hour basis—see pages 152–153.

General non-factory overheads (administration and other expenses) do not, however, form part of the total factory cost, and must not be included in the value of stock in hand.

They must, of course, be taken into account by the Sales Manager when fixing the selling price, which must both cover these additional non-factory oncost expenses and provide for a reasonable return on the money and effort invested in the production of the goods.

5. Standard Costs.

Standard costs imply the standardising of the costs for particular units, whether jobs or processes, and the process is carried down to the items or constituents of those costs.

This is effected by averaging costs over a standard period—one of normal output—and comparing future costs with these basic figures. The standards are revised, of course, if changes of methods and conditions intervene.

Their application is most advantageous in firms where specialisation or flow production is carried on, but the principle may be employed on job or contract work by careful compilation of the estimate as a standard for control purposes.

When fixing standard costs it is not only necessary to use past averages, but also to allow for future tendencies. It is therefore necessary to budget for some items of expense, but the data, if carefully compiled, serve as a continuous check on production and other costs. For example :—

PRODUCTION ORDER FOR 10,000 PARTS

	£ s. d.
Standard material allowance	10 0 0
,, wages ,, ...	5 0 0
,, oncost ,, ...	2 10 0

Description: Metal Part. *Part No*............... *Operation*..............

Date.	Order No.	Wages.	Material.	Over-head.	Total.	Quan-tity.	Cost per 100.	+ or −
		£ s. d.	£ s. d.	£ s. d.	£ s. d.		s. d.	
Standard	×	5 0 0	10 0 0	2 10 0	17 10 0	10,000	3 6	
10.5.41	1	5 10 0	10 10 0	2 15 0	18 15 0	10,000	3 9	+3*d.*
17.5.41	2	4 15 0	9 17 6	2 5 0	16 17 6	10,000	3 4½	−1½*d.*

If it is too long to await the completion of large production orders, costs are recorded for any period required, to within 24 hours. The above is, of course, a simple example, for in practice difficulties such as scrap allowances, operations not being completely finished, operations made out of sequence, etc., are encountered, but they do not affect the main theory of standards.

It is often simpler for the management to have details of differences only, instead of masses of cost data to unravel. Accounts may therefore be opened to record differences between standards and actual costs only.

Pro-duct.	Usual method.		Differences only.		Percent-ages (Standard = 100).
	Standard cost.	Actual	Up.	Down.	
	£ s. d.	£ s. d.	s. d.	£ s. d.	
No. 1	10 0 0	9 0 0	—	1 0 0	90
No. 2	5 0 0	5 10 0	10 0	—	110

FIG. 28.

A live foreman would, of course, take great interest in such differences, discover the reasons for them, and do his best to see that the necessary remedial action was taken.

6. Value of Costing to the Foreman.

The foreman, being essentially a practical man, is sometimes biased against cost accounting, feeling that it is impossible for "paper men" to give a true representation of the working of his shop. Admittedly it is of little use merely to tell a fore-

man that costs are too high, or that money has been wasted here, or an inefficient workman employed there—without substantiating and justifying these remarks. If the cost department co-operates with the foreman, giving him the facts, and establishing that they are not guess-work, but reflect accurately the work in the department, the foreman will identify his interests with those of the costing section and concentrate his attention on those inefficiencies which must be remedied. He will come to see that cost charts are like a boiler gauge, which he will need to keep under observation to see "how he is doing". The data which should be put before the foreman include all expenditures which he can control, either wholly or in part. They are :—

(1) direct costs : wages, materials, and direct expenses;

(2) indirect charges on his section : heating and lighting, etc.;

(3) the efficiency of his workmen : piece work earned and inspection reports;

(4) the efficiency of his plant : output, plant failure, short runs, repairs and maintenance, etc.

The foreman should be shown not only what the work has cost, but what it ought to have cost. It is not a question of berating him for an excess or discrepancy, but of assisting him to prevent its recurrence and to find means of improving his own efficiency and that of his department. No foreman, however shrewd and practical, can be fully efficient and control expenditure unless he is shown how much he is out.

Conversely, to enable this to be done, the foreman must in the first place play his part intelligently and conscientiously in making the original and basic cost data available, and seeing that the regulations and instructions in regard to the firm's system are faithfully, promptly, and fully observed by every one for whom he is responsible.

7. **FUNDAMENTALS OF**

Classes of Expenditure.	Sources of — Primary (Derivative).
FACTORY PRODUCTION AND FACTORY ONCOST EXPENDITURE CHARGED DIRECT:	
Production Wages (including employees' proportion of National Insurance).	Time-cards.
Production Material:	
(a) Raw material.	Buying Orders.
(b) Components made in factory.	Works Orders.
(c) ,, bought outside.	Buying Orders.
Oncost Wages.	Time-cards.
Oncost Material.	Buying Orders.
National Insurance (Employers' proportion).	Legislation.
Cash disbursements.	Cash Vouchers.
PERIODICAL FACTORY ONCOST EXPENDITURE NOT CHARGED DIRECT:	
Rent.	Lease or Agreement.
Rates.	Assessment.
Water.	Meter.
Gas.	,,
Electric Light.	,,
,, Power.	,,
Heating.	,, or Buying Order.
Depreciation.	Engineer's Opinion.
GENERAL FACTORY ONCOST EXPENDITURE NOT CHARGED DIRECT:	
Administrative Salaries, Bonuses, etc.	Allocation by the Directors.
Office Wages.	Pay-roll.
Printing, Stationery, Postages, Telegrams, Telephone, Accountants' Charges, Insurance (excluding National), etc., etc.	Various (Agreements, Buying Orders, Direct Payments).
Cash Disbursements.	Cash Vouchers.

* Other Oncost Wages and material, where not chargeable direct to

FIG.

COSTING

Information.	Methods of Allocation.	
Secondary (Confirmatory).	Primary (Basis).	Secondary (Medium).
Cash-book Entries.	Works Order Numbers.	Job Tickets and Pay-roll.
Suppliers' Invoices.	" " "	Requisitions and Stock Cards.
Cost Cards.	" " "	
Suppliers' Invoices.	" " "	
Cash-book Entries.	Standing " "	Job Tickets and Pay-roll.
Suppliers' Invoices.	" " "	Requisitions and Stock Cards.
Cash-book Entries.	Grouping of Employees.	Pay-roll.
" "	Nature and object of expenditure.	Cash-book Entries.
	PER PRELIMINARY ESTIMATE—based on (say) the previous year's accounts and subject to the under-mentioned considerations.	
Landlord's Demand.	Per cubic content.	Per Cost Journal.
Local Authority's Demand.	" " "	
Suppliers' Demand.	" meter.	
" "	" "	
" "	" "	
" "	" "	
" "	" " or Standing Order Numbers.	
Directors' Decision.	Per cost of machinery and plant having regard to location and life.	
Cash-book Entries. " " " "	* To Production Shops in proportion (where appropriate) to the totals for the preceding year of the Production Wages and Factory Oncost of the Production Shops to be charged, but excluding Production Material, or by other suitable methods according to circumstances.	
" "	Nature and object of expenditure.	Cash-book Entries.

Production Shops, to be apportioned between them on this basis.

29.

CHAPTER II

OVERHEAD EXPENSES OR ONCOSTS

A MORE detailed statement of the oncosts involved in factory overhead expenses is given in the following Expense Summary.

EXPENSE SUMMARY FOR PERIOD.................. TO ....

Symbol.		Manufacturing Departments.			Service Departments.					Total.
		A.	B.	Total.	St.	In.	D.O.	P. & D.	Total.	
L *	Indirect Labour									
M	Indirect Materials									
S	Supervision									
B B.1 B.2 B.3 B.4 B.5	Buildings Rent, Rates, Insurance Depreciation Repairs Heat and Light Cleaning									
R R.1 R.2 R.3 R.5	Plant Interest Depreciation Repairs Cleaning									
P P.1 P.2 P.3 P.6 P.7 P.5	Power Rent, etc. Depreciation Repairs Fuel Wages Cleaning									
X * *	Miscellaneous National Insurance Accident Compensation Overtime Defective Work Etc., etc.									

* These letters and numbers indicate Standing Orders as explained in this section.

FIG. 30.

1. Classification of Oncosts.

The object of classifying costs is to control them. When dealing with direct costs, control is achieved by comparing actual costs against separate estimates, but oncosts are allowed

for as a certain percentage on direct wages or other suitable basis, and are therefore more difficult to control. By classifying oncosts into groups, however, the management is in a position to compare the groups for corresponding periods and observe any irregularities or excesses. Groups are distinguished by standing order numbers, meaning that the numbers are for permanent use. They cover all the classes of oncost expenses of a business. For example :—Repairs may be denoted by letter C.; then C.5 would be repair to machine shop 5; C.18 would be repairs to steam plant 18; but if more detail is necessary, as in the expense summary sheet given above, where B. represents building expenses and R. plant expenses :—

	Repairs may be denoted by figure 3.
	Depreciation „ „ „ „ 2.
Machine shop No. 5.	Repair to Machine Shop plant = 5.R.3.
	„ „ building = 5.B.3.
Machine shop No. 2.	Depreciation of Machine Shop plant = 2.R.2.

and so on.

An alternative division of oncosts is into :—(1) Fixed charges, and (2) Variable charges. Fixed charges are those which do not vary with the volume of production, as rent, rates, taxes, insurance, directors' fees, etc. Variable charges are expenses which fluctuate largely in sympathy with the volume of production, such as power, light, heat, indirect labour and materials, repairs and maintenance.

It will be evident to the foreman that the unit charge of the fixed overhead expenses will be greater as the volume of production falls, which is the reason for the management's continual desire to run the shop as near capacity output as possible. In other words, production must not be allowed to fall below a *minimum* which recovers oncosts, thus enabling the Company to retain its employees and pay its way.

There is also the incidence of idleness oncost. During idle hours overhead expenses are mounting up, and, except for a few items, the oncost is the same whether a machine is working or not.

The variation in overhead as a department increases and decreases its output is illustrated in the following examples :—

PRODUCTION DEPARTMENT "A"
Weekly figures

	Case 1.	Case 2.	Case 3.
	Normal Load, say 80% 8,000 units.	Fall to 50% Load 5,000 units.	Rise to 100% Load 10,000 units.
Fixed weekly overhead expense	£100	£100	£100
Variable " " "	£64	£40	£80
Total " " " per unit	4·92*d.*	6·72*d.*	4·32*d.*
Loss in overhead expense per unit	—	1·80*d.*	—
Gain " " "	—	—	0·60*d.*

FIG. 31.

The maximum load of 100 per cent. means that all possible daywork machine hours are utilised. But owing to occasional breakdowns, and to the many kinds of delay, foreseen and otherwise, which usually occur, it is not reasonable to calculate on a maximum load basis. Therefore a normal load—*e.g.*, 80 per cent.—is assumed.

2. Allocation of Oncosts to the Product.

Having obtained the total overhead for the respective departments, the next step is to spread this overhead over the product on some suitable basis.

The methods generally used, which may have some particular advantages over the others according to local conditions, are :—

(1) a percentage on direct labour wages—say 150 per cent.; or alternatively a percentage on direct labour and on material (used where the labour charge is small and material high);

(2) a labour hour rate—say 3*s.* per hour;

(3) a machine hour rate—say 4*s.* per hour.

Method 1, to which the foreman is probably accustomed as it has the advantage of simplicity, may give rise to serious variations. For example, it makes no distinction between machine operations and bench work, or allowance for the fact that wages may vary from man to man, though on the same job.

As an illustration, assume that the same job is done by two

workers (*a*) and (*b*), rated at 2*s*. and 1*s*. per hour—that the former takes one hour and the latter 1 hour 30 minutes, then the cost will appear as follows :—

	(*a*).		(*b*).	
	s.	*d*.	*s*.	*d*.
Material	4	0	4	0
Direct labour . . .	2	0	1	6
Overhead (150 per cent.) .	3	0	2	3
Total cost	9	0	7	9

As a matter of experience, however, low-rated men require more supervision and attention than high-rated men, and the above comparison is likely to give a distorted picture of the relative costs of doing the job.

The foreman will also appreciate that when piecework rates are paid, Method 1 breaks down, as the overhead remains constant, irrespective of the time taken.

In Method 2 the total departmental overhead is divided by the production man-hours, and is allocated *pro rata* to the number of man-hours on each job. It takes no account of the use of different types of machinery, but finds an application in fitting and erecting shops where expensive machinery is not used.

By Method 3 the total expenses connected with each machine (or group of machines) are collected and divided by the production hours to give the machine hour rate. For example :—

MACHINE NO. 100. PRODUCTION HOURS 800

Symbol.	Oncost.	Amount.		
		£	*s*.	*d*.
B	Building Expenses	10	0	0
R	Depreciation, Repairs, etc.	100	0	0
P	Power	10	0	0
L	Indirect Labour	5	0	0
M	Supplies	5	0	0
S	Supervision	10	0	0
X	General Charges	20	0	0
		£160	0	0

Then the machine hour rate is 4*s*.

It will be noted that the hours the shop will work in a given accounting period are estimated, and many items of expense charged to the machine are also budgeted. An increase in the volume of work will decrease the machine hour rate, and vice

versa, yet if the machine is frequently idle a higher oncost cannot usually be charged to the customer. As a rule the method is only justified where a number of expensive machines are used.

Sometimes a combination of methods is used, especially if a product passes through more than one department. For example :—

Job 100.

	£	s.	d.
5 hours on machine rated 2*s*. per hour .		10	0
Wages of operator at 1*s*. per hour . .		5	0
		15	0
Bench work wages	1	0	0
Oncost at 75 per cent. on direct wages * .		15	0
Cost	£2	10	0

* This method is not necessarily to be preferred. The oncost may be allocated at an hourly rate, *e.g.*—

	£	s.	d.
Bench work wages, 10 hrs. at 2*s*. per hour .	1	0	0
Oncosts at 1*s*. 6*d*. per hour		15	0

3. Depreciation and Interest.

An important oncost item appearing in the specimen cost sheet is depreciation, or the diminution in value of a plant due to wear and tear. Plant and machinery are bought for the purpose of earning a revenue or income, but they wear out, and in due course have to be replaced. Provision for replacement has to be made out of the income derived from their use, and this charge must be spread over their life as fairly as possible. New capital to replace plant and other assets should never be necessary. To provide the money required for a new machine a certain amount has to be set aside annually from income, and this is called the creation of a depreciation reserve.

Depreciation is a rather intricate and controversial subject, and cannot be adequately treated in a short course. There are various ways of working out depreciation, and whichever is adopted, it constitutes an item of oncost. The following note is added merely to illustrate the two methods in most general use.

1. *The fixed instalment method of depreciation.* This consists in writing off each year an equal proportion of the original cost of the machine to reduce it to scrap value at the end of its life.

2. *The diminishing balance method.* This consists in deducting each year a fixed rate per cent. on the balance outstanding at the beginning of the year.

Example of Method 2.

	£
Cost of Machine No. 100 .	999
Depreciation rate . .	$33\frac{1}{3}$ per cent. p. a.
Value at end of 1st year .	666
,, ,, 2nd ,, .	444
,, ,, 3rd ,, .	296

and so on.

It should be noted, however, that the sums set aside each year (£333 at the end of the first year, £222 at the end of the second, £148 at the end of the third) would earn interest if invested, and this must be taken into account in determining the amount of the depreciation reserve.

The diminishing balance method has the advantage that the amount of depreciation decreases as the age of the machine increases—*i.e.*, at the time when expenditure on maintenance and repairs is likely to rise. The foreman should note that while the useful life of a machine can only be estimated by the engineer, the method or rate of depreciation is fixed by the cost accountant to meet the conditions and requirements most suitable to the firm.

Interest on Capital.

It will also have been noticed from the expense summary sheet that interest is charged on the plant, and the foreman may inquire why a firm should charge itself with interest on a machine it owns. The reason is that the firm might have put the money into a safe investment earning interest; it preferred, however, to buy a machine with the money. The machine ought, therefore, to return this safe rate of interest.

If this interest is charged against the plant purchased, the final profit made by the Company is an additional amount which can be reckoned as a reward for taking the risk of trading, and knowing how to run the plant for that purpose.

CHAPTER III

REMUNERATION AND WAGE PAYMENT

WAGES are the nominal or money payment for work performed—the reward of labour which is one of the essential factors in production. The price obtained for the goods produced has to remunerate all the factors required for production—land, capital, and enterprise, as well as labour—and the reward of each factor has to be reasonable and equitable, otherwise it will sooner or later be withdrawn from service by its owners.

The interests of labour and capital will be seen to be the same in the sense that both can gain from an increase in output, but opposed inasmuch as both capital and labour seek to increase their respective shares. The level of wages varies between a minimum which each class of labour can take to maintain its habitual or conventional standard of living and a maximum represented by the net value of the work performed. Within this range the actual level of wages is settled by bargaining and agreement between the Trade Unions and the Employers' Federation in the industry.

1. Methods of Wage Payment.

There are several methods of wage payment, dependent on the nature of the industry concerned. For the payment of basic wages, time rates, piece rates, or premium bonus systems are employed.

Under time rates the workman is paid so much per hour, day, or week. They are generally suitable where the quality of work is important and the work cannot be standardised. Careful supervision is necessary, as time rates contain no inspiration to workmen to increase production. Under piece rates a fixed sum is paid per piece of work or unit of output, but usually with strict regard to previous established day rates. First-class workers generally prefer piece rates, provided there is no price cutting or undue speeding up and overstrain. The difficulty of setting and revising fundamental piece rates is

often of a high order. They reduce, however, the need of close supervision by providing a powerful incentive to workers to maximise their output, as labour gains all the time saved from the allowed or standard time of production.

All the premium bonus systems of wage payment are variants of the possible methods of sharing the time saved between labour and the firm.

A simple way of representing the variations in wages with increased output is shown in the following diagram, where Ws

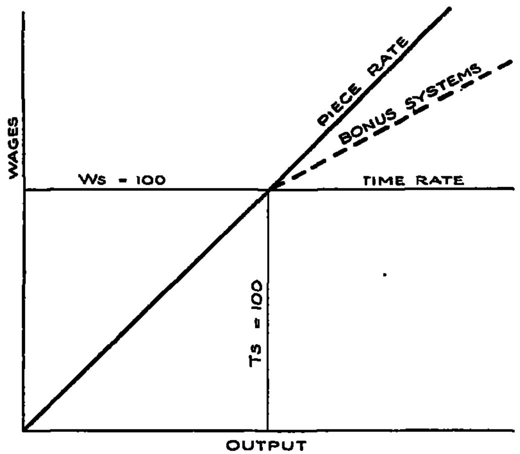


FIG. 32.

is wages and Ts is the output set per day or shift. Under time rates, the wages paid remain constant, independent of the output. When piece rates are paid the wages increase in direct proportion to the output, and there seems to be a principle of equity involved in paying a man in proportion to the work he accomplishes. As, however, time wages have usually to be guaranteed as a minimum, even if the operative falls short of the standard output, there is, on the other hand, a good deal to be said for sharing the gains that result when the standard output is exceeded.

2. British Premium Bonus Systems (1-Point Systems).

There are various methods by which a proportion of the time saved on any specific job is credited to the workman,

but only the best-known of the British systems will be discussed.

Under the Halsey system one-third of the saving is allowed to the operative and under the Weir system one-half. These bonuses may be simply expressed in symbols, which will be found useful in working out examples.

Let Hs be the hours allowed or standard time for the job.
HA the actual time taken on the job.
Rh the workman's rate per hour.

Then the time saved is Hs — HA hours; and the Halsey bonus is one-third (Hs — HA) Rh.

Let us assume that a workman's rate is 2*s*. per hour, and that he is given 6 hours to do a job and completes it in 4 hours.

Then Rh = 2*s*.
Hs = 6 hours.
HA = 4 hours.

Then the Halsey Bonus is $\frac{1}{3}(6 - 4) \times 2s. = 1s.\ 4d.$

The Weir Bonus is $\frac{1}{2}$(Hs — HA)Rh, which for the same workman and the same job would be $\frac{1}{2} \times 2 \times 2s. = 2s.$

Under the Rowan system the proportion of the time saved is not constant, but variable—viz., the ratio of the time saved to the standard time. The Rowan bonus is, therefore :—

$$\frac{\text{HA}}{\text{Hs}}\,(\text{Hs} - \text{HA})\ \text{Rh}$$

e.g., on the same basis as the above examples the Rowan bonus is :—

$$\tfrac{4}{6} \times 2 \times 2s. = \tfrac{8}{3}s. = 2s.\ 8d.$$

For small savings in time from the standard time, the Rowan system is more generous than the Weir system (50 : 50), but when half the allowed time is saved the bonuses are equal. Moreover, under the Rowan system the workman cannot increase his earnings more than double. It presumes, therefore, that allowed times are correctly set and can be improved on only to a limited extent, but offers a generous bonus to do so.

This correct setting of allowed times is the basis of all scientific wage-payment systems, including the so-called Point Systems, which will be referred to below. The accurate

measurement of the amount of work which can be legitimately expected by the management can be achieved only by motion and time study. Motion study comes first, and consists in eliminating all wasteful and inefficient movements and fixing standard conditions for doing a job. Several employees of average skill are then timed, and after the results have been analysed and criticised, and due allowances made both for the operative and the class of job, an average standard time may be fixed which will not have to be changed unless the method of performance is altered.

Point Systems.

All point systems depend on this scientific predetermination or standardisation of the amount of work to be done in a given time—usually a minute, as in the case of the Bedaux system. The unit of work or B-point is fixed by the Bedaux engineers after making allowances for rest and delays, based on observation and experience. 60 B's constitute an hour's task, and if the number produced by a worker in an hour exceeds this, he is given 75 to 90 per cent. of the value of excess B's as a premium, the balance going to indirect labour and supervision. It is possible to report delays in minutes, and allowances are made according to the delay being due to the employees' fault or not. The system obviously entails considerable paper work, from the daily cards from which the operatives' premiums are worked out, to the posting sheet for totals and the analysis sheet from which the efficiency of each section or department is calculated and reasons given for any departure from the planned output. A weekly recapitulation sheet gives an overall index of efficiency. The system possesses, therefore, the advantage of affording an effective means of strong managerial control.

American systems of incentive payment employ similar methods of sharing the gain obtained by working faster than the standard rate, but frequently also introduce a strong incentive to attain the standard task by increasing the workman's rate at this point, as in the task and bonus system, Emerson's efficiency system, etc.

3. Collective Bonus Plans.

Under the individual bonus systems the incentive is strong and immediate, but there is no inducement to maintain quality

or foster co-operation between employees. For this reason group bonuses are in some cases to be preferred, as constituting a steady and persistent stimulus to organised effort. This system also relieves the necessity for close supervision, as employees do not like to see their bonus being jeopardised by slackers. The system is, of course, essential where the contribution of each of the team cannot readily be measured (as in a team of forge operators), and readily applicable where the output of the team is recorded—*e.g.*, number of chassis erected per week. In other cases it can be applied to a shop or department by relating the bonus to the difference between the estimated wages and the actual wages, taking output into consideration.

Profit sharing schemes may be considered a development of the collective bonus method in which the group is extended to include the whole of a firm's employees, and thus induce a co-operative effort between all the groups concerned. They differ, however, in the respect that the bonus is not only related to the working efficiency of the operatives, but also to other factors which are obviously involved in the firm's ability to make a profit. Nevertheless, profit sharing tends to identify the interest of the employees with that of the firm, and there seems to be a principle of equity involved in their sharing its good fortune. Profit sharing may or may not be associated with the actual holding by the employees of shares in the company, but if a block of shares is set aside to be held by trustees for the employees, special precautions are usually devised for the protection of these shares.

4. How Payment by Results affects Costs.

Under all these systems of payment the total factory cost per unit decreases with increase of output, but faster under day rates than under the piece system, with bonus systems intermediate if the increase in output is equal in all three cases. This is due to the overheads remaining nearly constant although the output is increased. Considering first the effect on labour cost per unit, the variation with increased output is represented in Fig. 33, p. 165. Under piece rate payment it is, of course, constant.

The overhead cost or oncost per unit falls under all three systems as the output increases, so that when labour cost and

oncost per unit are added together to obtain factory cost the correctness of the above statement in regard to factory cost will be apparent.

This is the reason why enlightened employers support a high wages plan, as they are aware that the higher the earnings of the employees the lower are the oncosts per unit and the total factory cost per unit, and what they are chiefly concerned with is the difference between the cost of production and the price obtained for the product. This assumes, of course, that the standard times or tasks are correctly set.

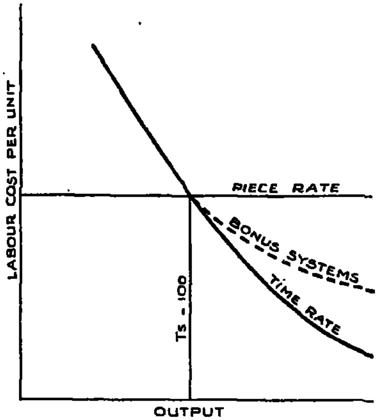


FIG. 33.

The foreman will have no difficulty in appreciating the above principles of the economy of high earnings, and will consider it his duty to assist each operative to earn the highest bonus his skill permits, as by so doing he assists the firm to lower the total cost of production per unit.

5. Time Keeping and Time Booking.

As the time of operatives has to be paid for, the checking of time is obviously important to the management. Production labour will be kept fully employed only if each workman's time is accounted for. Accurate time keeping is, in fact, the basis of the ascertainment of labour cost.

The method of recording working time requires careful attention. The traditional method involved employing a watchman at the gate who knew the men by sight. Sub-

sequently a simple tally system was devised, and even today a double check tally system is used, the use of a main tally board at the works entrance and departmental tally boards under the supervision of the foremen. When a workman enters he takes the tally disc with his number from the section of the board headed OUT and transfers to the IN section, or throws it into a suitable container which the gateman collects at the appointed time. The gate-keeper or time-keeper is able, in this way, to keep a simple record of absentees, late-comers and overtime workers, but clerical work is involved in issuing short-time or overtime slips. The system is open to obvious abuses, but from the point of view of on and off times may be as good, though it cannot be so informative, as a mechanical recording system.

The most satisfactory way of recording the time worked by employees is by means of electrically controlled time recorders, of which there are several reliable makes. Both dial time recorders and card recorders are in use, but the latter are generally preferable.

A recorder should be placed near the door of the shop, in a position to permit the employees to file by quickly. The time cards giving a record of all arrivals and departures of employees for a week are housed in two racks, one on each side of the recorder, and marked respectively IN and OUT. The reverse side of the time cards may be used to indicate the hours worked, the overtime, and the make-up of the wages. Time recording instructions must be drawn up so that the employees may clearly know the firm's rules in this respect, deductions for lateness, etc.

Lists should be kept of clocking irregularities, omissions to clock, late-in and early-out clocking, and remarks made on the reasons. A record of lost time should also be kept on a suitable form, with a column for reasons and remarks. Attention may be concentrated on lost time by charting it, particularly if expressed in money value.

The foreman's interest in the time cards is obvious. He can observe at a glance the number of men off duty, and make his plans to deal with the situation, advising the personnel manager immediately of his requirements. It is the foreman's duty to be on the look-out for any erasures or tampering with time cards. If anything out of the usual routine occurs, the

foreman should sign, as only the signature of a properly authorised person would be accepted in such circumstances.

6. Payroll Compilation and Wage Payment.

It is necessary to know not only what period a man is on the premises, but also the time actually spent at work and on what jobs. The recording of job times is, in fact, essential for the calculation of wages based on a premium or bonus system. Manual time sheets may still be found in use with columns for Order Number, commencing and finishing time, which the employees fill in and the foreman countersigns. The total hours and money values are filled out in the wages office.

Automatic time recorders are, however, always preferable. They stamp the on and off times for each job—one card per job. A man must be issued with only one card at a time. This is accomplished by not issuing him with a new card except in exchange for that recording his time on the job he has finished. From the clocked-off job cards the time is abstracted, converted into wages and bonus, and the data transferred to the workman's wages compilation and to the job cost.

In the case of machine breakdown or any other cause of enforced idleness, the operative should be issued with a waiting card, otherwise the cost of the job is inflated.

Efficiency in the preparation of payrolls depends on the accuracy of the time bookings. The payroll may be compiled as shown in the following table.

PAYROLL

Shop.................................. Week ending..................................

Clock No.	Name.	Grade.	Rate.	Hours.			Gross amount.	Deductions.			Net amount.
				Day.	Over-time.	Night.		Health.	Unem-ploy-ment	Income Tax.	

FIG. 34.

A ready reckoner is useful, indicating the value of hours and fractional hour's work in the range of rates applicable to the shop.

As much use as possible should be made, however, of labour-saving office machinery, such as the Burroughs machine and the Hollerith or Powers-Samas equipment. The former machine will give the payroll, a record of earnings, etc., a pay-envelope, and a receipt in one operation. The latter type of machine involves the use of punched cards, and any desired analysis of wages may be made by simply running the cards through the tabulating machine.

Payment of Wages.

The sealed envelope method of paying wages is the one most used. If the envelope is transparent, the amount of money may be verified with the amount on the pay slip without opening the envelope.

To save time in wage paying, full use should be made of mechanical devices, such as automatic cashiers and machines for folding notes and sealing envelopes.

There are always possibilities of fraud and error in wage-payment, and controls should be devised to prevent collusion of employees. Each clerk's work should be checked as far as possible by the results of another clerk's work—*e.g.*, job cost summary against direct labour payroll.

Whatever system of wage payment may be adopted, careful consideration must be given to the psychological factors involved. The employees must be assured of its fairness—they must be able to understand it without difficulty and to check their earnings easily. It must be acceptable to them—*e.g.*, in spite of the individual desire to gain, cases are known where operatives have asked for the introduction of a group bonus. Rates must not be modified without good reason and, if necessary, demonstration. Sharp practice must not be indulged in when time setting—*i.e.*, an average operative under really representative conditions must be chosen. This is a point which the foreman can influence, and which, in fact, it is his duty to ensure. He stands closest to the operatives, and he has a responsibility towards them as well as to the management. He must, where necessary, explain the system to them, and see that within its framework they do the best for themselves.

CHAPTER IV

RATE SETTING AND OPERATION PLANNING

1. Rate Setting.

THE basis of all piece work and premium bonus prices is rate setting, or setting time for the operations to be carried out by operatives of stated rates of pay. In other words, the determination of fair piece work wages is reduced, subject to agreement between employers and employees, to the determination of fair working times. The object of rate setting is, of course, the predetermination of labour costs.

There are several methods of rate setting, of which we may first mention the setting of a job time by the foreman based on his experience. While there is something to be said for this method in practice—and, in fact, reference to the foreman's experience is desirable—it is too much to expect him to combine with his manifold duties the expert knowledge of rate setting which is required to meet the needs of modern industrial conditions.

A sounder method is to calculate the operation times from formulae on metal cutting, combined with all other data relevant to the job. By this method the technique of a particular shop would be taken into consideration, but no allowance would be made in the normal rate to offset defects in machines or abnormal labour or other conditions. Such variables would not affect basic job rates, but to compensate for them, while they exist, temporary allowances from basic rates would be made.

The method generally used in rate setting is to employ an expert rate setter, skilled not only in the class of work which the shop performs, but also in time study and time setting. Rate setting without experience is, of course, unthinkable; and there are three distinct types of knowledge involved in the make-up of a successful rate setter :—

(1) Practical knowledge of machine tools and processes.

(2) Knowledge of the scientific methods of motion study and time study.

(3) Knowledge of the human factor, and of relaxation and all other reasonable allowances.

The third or psychological aspect is necessary for the rate setter to gain the confidence of the operatives, without which stable conditions will not be maintained.

2. Steps in Rate Setting. Operation Planning.

In setting the time for a given job, the first step is to analyse the job into its constituent operations. Usually there are several ways of doing a job, and the operation planner has to choose the one which will yield the lowest overall production time when using the machines that the firm has available.

Production planning involves not only the types of operation to be used, but the order of these operations; not only the time the operations should take, but how the plant should be laid out to do them. The importance of the sequence of the operations in obtaining lowest machining cost hardly needs emphasis to the foreman, as he is in a position to appreciate the skill of a methods engineer who minimises, for example, the number of chucking operations for a job, employs multiple tooling, and devises ingenious jigs and fixtures.

Under war conditions, however, it may give greater production, even though it may cost more, to tool up a row of machines, each for a single operation, and employ women or other unskilled labour to operate them. In either case the correct sequence of operations is the vital factor for minimum production time. For example, shell components may be made on a turret tooled up to give the complete series of operations, or the operations may be carried out individually on a line of lathes, each tooled for one operation carried out by an unskilled worker.

Planning for least cost involves also the fullest use of standardisation, not only of machines and tools, but dimensions, sizes, and operations. This, of course, facilitates and simplifies the rate setter's job and permits greater accuracy and certainty in allowed times.

Operation Planning.

The following may be taken as the headings of a simple operation layout sheet from which the routing of the product and the balancing of machine outputs may be effected—*e.g.*, it will be seen that one punching machine will keep nine bench workers occupied.

OPERATION LAYOUT SHEET

Part.	Operation.		Machine.	Time.
	No.	Description.		
Base Plate	1 2 3	Cut Punch Bench	C.20 P.1 —	3 mins. 1 min. 9 mins.

FIG. 35.

The headings for an operation planning sheet are given below, to which a column might be added to indicate the route of the product if the work is being done in a shop with grouped machines.

OPERATION PLANNING SHEET

Operation.	M/C tool used.	Labour grade.	Piece work.		Tools re-quired.	Jigs and gauges.
			Time.	Price.		

FIG. 36.

In the grouped layout of machines it is essential to guard against waste of time in moving or transporting work from operation to operation. This potential leakage of time is minimised in flow or continuous production methods for which production flow is the keynote of layout.

Make-up of Operation Cycle Time.

Production time includes both operating time and preparation and service time. The latter is taken up by obtaining in-

structions, setting up, obtaining jigs, tools, and gauges, loading or mounting the work, adjusting the machine, adjusting the tools, removing the work, and so on.

The rate setter has to determine the non-operating as well as the *operating time*, but the *former is more a matter of* knowledge and judgment than a matter of rule. Setting-up time will not be considered further here, except to note that in high-output machines, such as capstans and autos, it may be considerable, and that accuracy in setting allowance is as important as in time per piece. The rate setter is principally concerned with setting floor-to-floor times (F.F.T.); and placing the work in position, and removing it when the operation is completed, are included in the piece work rate.

For autos the relationship between the various times constituting a work cycle is as follows :—

Cycle time.	F.F.T. plus bar-feeding allowance.
Operation time.	Cycle time plus allowance for fatigue and tool adjustment.
Basic time.	Operation time plus contingency allowance.
Piece work time.	(Basic time plus 33⅓ per cent.) divided by number of machines.
Piece work price.	Piece work time multiplied by basic rate.

3. The Basis of Rate Setting. Time Study.

The foreman should understand that the maintenance of the planned production schedule is dependent on the practical accuracy of the time setting. Time study, which has been referred to elsewhere, is the true basis of equitable standard times. It presupposes that motion study (methods study) has first been carried out. Unless conditions have been settled or standardised, the reliability of the allowed times cannot be guaranteed. Conditions must not only be technically right, but psychologically right.

It is much better to have the machines, tools, materials, and layout right than to make a correction for sub-standard conditions, and to have the operative properly trained and in a co-operative frame of mind than sceptical, if not resentful. A heavy tax will be put on the time setter's experience in determining the proper allowances for fatigue, handling work,

unavoidable delays, and so on, without adding to his difficulties the fact that the conditions and the rating of the employee may alter.

The fairness, conscientiousness, and honesty of the time setter must therefore be beyond question, so that he may have the confidence both of the management and the employees. His job is to establish fairly the minimum times which should be required of an average operative of normal ability. A tight time allowance will defeat its own object, as the employees will be discouraged; on the other hand, an arbitrary cut in rates will cause loss of confidence.

Relation of the Foreman to the Rate Setter.

A rate setter occupies a difficult position, with responsibilities both to the management and the men. These difficulties should be appreciated by the foreman, and it is his duty to co-operate with the rate setter, whether times are set by time study or established by experience. In time study the foreman should ensure that the conditions represent those under which the operatives will normally work, that the operative being timed is typical, and that he understands the purpose of the study. When time studies cannot be taken—*e.g.*, for short production runs—the foreman should put his knowledge of the shop conditions at the rate setter's disposal.

SECTION V

READING AND STUDYING

CHAPTER I

READING AND STUDYING

In the minds of some, " lectures " and " reading ' stand as alternatives; as parallel means of achieving a level of knowledge, so that one may choose either the line of unguided study by reading or the avenue of studentship under a lecturer from whose notes and exposition knowledge may result. Such a notion is not only fallacious, but dangerous. It puts studying, the acquisition of knowledge, on the plane of a memory exercise, on the level of the " crammer " whose only concern is to remember sufficient facts and data to answer a given set of questions. Reading stands in the same relation to studying as the clinical experience does to the medical lectures in a hospital; the doctor-to-be learns his principles and his basic facts from his professor or specialists and translates such fundamentals into active knowledge in the experiments and observations of the laboratory and theatre. So with any course of study—lectures give a quantum of information and the exposition of a principle. And in the supplementary reading that is conjoined to such lecture-study the student widens and deepens his command of principles and facts, and sharpens his knowledge against the ideas of yet another mind.

Reading thus has a dual rôle to play: it serves to give new facts, new information; it serves, too, to focus what has been learned from a lecture. This principle is the basis on which books should be selected. In the earlier stages of a course of study such books should be read as give similar facts to those learned in a lecture, but set now in a wider scope or approached from a somewhat different angle. But, to the more advanced student, books can be recommended which challenge the factual data he has imbibed, and lead him on to apply his own understanding of the subject to a solution of the impasse thus created.

1. The Choice of Books.

Some say that reading is useless, and that only knowledge derived from one's own experience is of any value. This so-called "practical man's" view is altogether wrong; a good book is the epitome of another man's experience, and if the "practical man" refuses to read it he denies himself valuable knowledge which may not otherwise come his way in a lifetime.

In the bibliography which follows the selection of titles has intentionally been kept small. And on the valid assumption that most of the participants in the newly devised Foremanship Courses will be new to codified studies in this field, the choice has been made primarily with the first aim in view. The ten books set out in the first list are all concerned to amplify the teaching of one or other aspect of the subject-matter of this book. They should thus be read in relation to their subject. To read one of these books from cover to cover is perhaps the easiest way to miss its real value in relation to the Course. Each book chosen should be read in connection with its section of this book—perhaps even prefaced by a cursory glance over the contents of that section or the corresponding lecture notes—in order to bring out more clearly the contributions that the supplementary reading can be expected to make.

The eight Advanced Books are to serve a different aim. They are more akin to the "reference book" to be used for more special information or for providing a screen on which to throw the knowledge acquired in the Course.* Whichever one is selected should be treated as a whole, read through in entirety when the run of the Course is completed.

2. How to Read.

"How should I read?" may sound to some people a pointless question to ask. But to the man or woman who is embarking on serious study for the first time the question may well be very pertinent. It can be quite simply answered. Reading is part of studying; hence it must be treated with equal concentration and care. Trains or buses are the least desirable environment for the earnest study-reader. Nor should one take up the text-book when feeling mentally fatigued or dis-

* Nos. 11 and 13 are definitely reference books, for special information purposes.

tracted. One hour's quiet serious reading is worth more than an afternoon's perusal of a book with distractions on every side.

First of all, take reading seriously.

Secondly, beware of marking the text-book. Notes are valuable, but they should be notes in the notebook, and not notes on the printed page. Only rarely should passages be copied down verbatim. The best notes are the two- or three-word headings, the tabulated series of points, the jotting to recall an illustration—that is, the brief comment that labels the striking point in the book and serves to set the mind on the right track when recapitulation is required. Note-taking should be a regular part of study-reading, and the notes should be the link between the Course and the book.

Thirdly, read with reflection. More haste, less speed, is as true in reading as elsewhere. Many students may even find advantage in making a first general reading of the relevant sections of the book, to get a comprehensive view, and then going back to read in detail and note the points that stand out.

Fourthly, read connectedly and to plan. Study taken seriously means time specifically allocated; and reading must feature in the time-table. Continuity of thought and study is easier to maintain when a section is read within a limited span of time rather than being spread intermittently over a lengthy period.

Finally, read for revision while the study is in progress, rather than when the whole Course is completed. With each individual section of a syllabus still freshly held in mind, memory is more apt to strike attention on a point recently dealt with in a lecture and now re-met in the book. Whereas with reading postponed to the end, by way of revision, it is difficult for the mind to bring back clearly questions, problems, and illustrations, which, if linked with the views of the author, would lend to the latter more point, greater value.

It is said that the human brain cannot study effectively after thirty years of age. That it is slower and less receptive may be conceded : also that there is less inclination to study. But it would bode ill for progress if the man or woman in the real prime of adult life were unable to acquire and extend knowledge by reading and study. On the contrary, the truth is that with

sincerity and keenness of purpose man's brain will follow his will at any active stage of life.

Very few persons have any idea of the extent to which a firm and enduring grasp of an ordered body of knowledge on any ordinary subject may be gained by one who is determined, patient, self-disciplined, and who follows faithfully and persistently, *at his own pace*, a sound plan of reading and study. Such progress is conditioned by innate mental ability, but within this limitation great advance is possible. It may not be rapid, for there are few brilliant students; it may even be slow, for to many it will be a difficult, uphill struggle; but it is within the power of every one to make it sure.

So even the older foreman need not shrink from a course of reading and study, but can expect to win from such effort a new, clear, and reliable understanding of his duties and responsibilities and so a sound basis for contributing to effective management.

CHAPTER II

A READING COURSE FOR FOREMANSHIP TRAINING

1. Recommended Books.

Book No.	Title and Author.	Publisher and Price.
1	"Modern Foremanship." Burnham, T. H.	Pitman. 7*s*. 6*d*.
2	"Handbook for Foremen." Casson, H. N.	The Efficiency Magazine. 5*s*.
3	"Fundamentals of Industrial Administration." Elbourne, E. T.	Macdonald & Evans. 15*s*.
4	"Management and Labour." Fenelon, K. G.	Methuen. 8*s*. 6*d*.
5	"The Aim and Purpose of a Labour Department." Fullwood, J. H.	Institute of Labour Management. 6*d*.
6	"Better Foremanship." Gardiner, G.	McGraw-Hill. 17*s*. 6*d*.
7	"Training in Foremanship and Management." (1941 edn.) Gillespie, J. J.	Pitman. 8*s*. 6*d*.
8	"How to be a Good Foreman." Reitell.	Ronald Press. 8*s*. 6*d*.
9	"Manual for Executives and Foremen." Schell, E. H., and Gilmore, F. F.	McGraw-Hill. 14*s*.
10	"The Health and Efficiency of Munition Workers." Vernon, H. M.	Oxford University Press. 8*s*. 6*d*.

A Selection of Books for Advanced Reading.

11	"Cost and Production Handbook." Editor: Alford, L. P.	Ronald Press. 45*s*.
12	"Planning, Estimating, and Rate-fixing." Whitehead, A. C.	Pitman. 12*s*. 6*d*.
13	"Factory Training Manual." Editor: Pugh, R.	Management Publications Trust. 6*s*. 6*d*.
14	"The Technique of Executive Control." Schell, E. H.	McGraw-Hill. 14*s*.
15	"Personnel Administration." Tead, O., and Metcalf, H. C.	McGraw-Hill. 24*s*.
16	"New Techniques for Foremen and Supervisors." Walton, A.	McGraw-Hill. 17*s*. 6*d*.
17	"An Introduction to Psychology." Wimms, J. H.	Charles & Son, Ltd. 2*s*.
18	"Industrial Psychology." Editor: Myers, Chas. E.	Home University Library. 3*s*.

NOTE.—All the above books are obtainable on loan from The Management Library, London.

2. Guide to Selective Reading.

Book No. on foregoing List:	I.	II.	III.	IV.
	Chapters of each book pertaining to the above Sections:			
1	I–V	XIV	VI–IX, XI–XIII	X, XV
2	I, VII–IX	II–IV	V–VI	—
3	—	XIII	XI–XII, XXIV	XVIII
4	I	—	III–VIII	X–XI
5	—	—	Whole book	—
6	IX, XIII (pp. 181–187)	VII, X, XIII (pp. 188–200)	I–V, XI–XII	VI, VIII
7	I–VI, VII–X	XI, XIV–XVI	XII–XIII	XVII–XIX
8	I, III–IV, VI, XX	VIII–XIV	II, V	VII, XV–XIX
9	I–II	III–V, VII–X	VI	—
10	—	—	Whole book	—

APPENDIX

EXAMINATION PAPERS ON FOREMANSHIP AND WORKS SUPERVISION

Selected from papers, assessed by the Institute of Industrial Administration, set for the " Certificate Course in Foremanship and Works Supervision ".

General Principles of Foremanship and Supervision

1. Explain by means of diagrams the systems of factory administration known as " Line or Military, " " Functional ", and " Staff and Line ".
2. What are the principal advantages of the " Staff and Line " system of factory administration ?
3. Discuss the importance of Co-operation in the factory, and the methods by which foremen can foster the co-operative spirit.
4. Compare the duties and responsibilities of a foreman of production in a large and small organisation.
5. Comment on the following statement : " . . . The spirit of the department is made or marred by the foreman."
6. Suggest some of the qualities most desirable in a foreman of production, and discuss their importance.
7. Discuss the necessity for leadership as a feature of the supervision in a workshop.
8. What are the responsibilities of a foreman of a production department to (*a*) the management; (*b*) the operatives ?
9. In what way can foremen operate to minimise the number of accidents occurring in a factory ?
10. Why are Machine Efficiency Reports sometimes used as a feature of production control ?
11. What are the prevalent sources of waste in a factory and the measures sometimes adopted to prevent such waste ?
12. What is Industrial Psychology ? What is its purpose in industry ?

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1. What are the differences in the duties of a foreman in a jobbing shop and a shop engaged in mass or continuous production ?
2. In what ways can a foreman keep waste in his department at a minimum ?
3. What factors in a foreman's make-up help him to develop leadership ?

4. What is meant by tone of a workshop? On what factors does it depend?

5. What qualities additional to leadership should you look for in a man intended for promotion to foreman or supervisor?

6. What should be the rôle of a foreman in accident prevention?

7. What records should a foreman keep to control the efficiency of the plant in his department?

8. What is the value of a Works Committee? What subjects can it usefully discuss?

9. What are the duties of a foreman towards (*a*) the management; (*b*) the employees? Do these duties clash?

10. Is there any connection between physique and temperament? Would it be a safe guide in choosing (1) foremen; (2) salesmen?

Or Suggest a suitable temperamental type for a supervisor.

11. Distinguish between responsibilities and duties. Discuss briefly the responsibilities of a foreman.

12. How should you deal with operatives of the following types: Combative; timid; conceited; unreliable; grumblers; work-spoilers?

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1. Enumerate the factors affecting the tone of a Workshop, stating (*a*) the internal factors; (*b*) the external factors, that influence this problem, and indicating adverse and favourable conditions. (This may be set out in chart form.)

2. What are the qualities of a successful Foreman? How can these be developed?

3. Define the nature of the essential co-operation that is required between the Foreman and the departments enumerated below:—

(*a*) The Inspection Department; (*b*) the Production Department; (*c*) the Time Study Department; (*d*) the Maintenance Department; (*e*) the Cost Office.

Explain means of attaining and ensuring this in ONE particular.

4. State the methods used in, and the achievements of, employee representation in various phrases of Industrial Organisation.

5. Define the main functions of Industrial Relationship between the Foreman and (*a*) the employee; (*b*) the management.

Explain how this relationship can be cultivated and maintained.

6. Accident Prevention is an essential function of Foremanship duties. Explain the steps which are usually taken to control this responsibility.

7. What steps should be taken to ensure Plant Efficiency?

8. Describe the different types of Factory Organisation, stating (*a*) the advantages; (*b*) the disadvantages, of each.

9. Should you be promoted to the position of Supervisor to another department, what should be the main points of your initial investigations into the efficiency of your new Department?

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1. Given that methods of supervision depend on whether the works is a small or a large one, illustrate this by considering a foreman's job in workshops where (*a*) 10 persons; (*b*) 500 persons, are employed.

2. The foreman is sometimes termed a supervisor. Indicate and discuss what is supervised: men, work, or both.

3. Draw up a rating chart to assist in ascertaining if men have suitable qualities to become foremen.

4. What line should a foreman take when one of his men complains that the job rate allowed him is insufficient?

5. If in the opinion of a foreman the method of manufacture planned for a component is not the best, what procedure should he follow?

6. Differentiate between authority and leadership. Which is the more important factor in a workshop? Why?

7. What can a foreman do to conserve the employees' health and capacity to work?

8. How does a knowledge of industrial psychology assist the foreman in the performance of his job?

9. What are the chief sources of waste in a factory? What measures can a foreman adopt to prevent them?

10. Discuss the value in a works of a suggestion scheme. What should be the attitude of a foreman to such a scheme?

11. Distinguish between (*a*) accident liability and accident proneness; (*b*) accident frequency rates and accident severity rate.

Elements of Labour Management

1. Discuss the advantages of an Employment Department as part of the factory organisation.

2. What are the functions of the Personnel Department in a large industrial organisation?

3. Discuss the advantages of good selection of workers.

4. Why is the question of training new workers important? What methods are adopted in various organisations?

5. What should be understood by the term "Labour Turnover"? Why should an analysed record be kept?

6. How does the quality of the working conditions affect the efficiency of production?

7. What are the essential features of a Job Specification used for the purpose of employee selection?

8. How can foremen assist in promoting the health of the workers in a factory?

9. Discuss the advantages of social and recreational activities as a feature of industrial welfare.

10. Give a brief history of factory legislation in this country, and comment on its trend.

11. What are the features of importance in securing good lighting and ventilation in a factory?

12. What provision is made for compensating workers in the event of injury through an accident occurring in the factory? What constitutes an industrial accident?

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1. What are the advantages to a foreman or supervisor of a Labour Department? Are there any disadvantages?
2. What are the principal duties of a Labour Department?
3. What should be understood by vocational selection? When should the foreman assist in the selection of employees?
4. Should employees be trained by the foreman or by a training department? Give reasons for your answer.
5. Under what headings should you classify working conditions in a shop? Indicate how far the foreman is responsible for each.
6. In a firm of about 500 employees, what employment records should you expect to find? Indicate their use.
7. Explain how a Labour Department keeps in touch with employees after engagement.
8. What were the principal changes introduced by the 1937 Factory Act? Classify under headings.
9. What are Home Office Orders? Why are they issued? Illustrate in reference to your own industry, or say to what subjects they principally relate.
10. What are the essentials to observe in claiming workmen's compensation? Indicate briefly how compensation is assessed.
11. What should be included under Welfare work? Indicate the order of importance you should attach to the various sections.
12. What is the foreman's duty in relation to a firm's clubs and recreation schemes?

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1. Enumerate the functions under the control of a well organised Labour Department, indicating their advantages.
2. What is meant by Labour Turnover?

State the causes and effects of a High Labour Turnover (this can be shown in concise chart lay-out if preferred).

3. In the case of an enforced reduction in production requirements of the factory for a limited period, what methods should be adopted to overcome the discharge of workers? Support the method adopted by reasons for the action taken.
4. What are the uses of job specifications and job analyses?

How should these be prepared and compiled?

How is the knowledge of the foreman utilised in this respect?

5. Suggest methods which could be used in keeping in touch with employees. What advantages are claimed for the methods given?
6. Mention the various types of selection tests in general use. Give a short explanation of each, stating (*a*) of what it consists; (*b*) how it is applied; (*c*) what are its main uses.

7. Indicate the recruitment sources of various types of labour (preferably in chart lay-out) showing (*a*) type of labour; (*b*) source of supply; (*c*) how obtained and selected.

8. Mention some of the new provisions introduced by the Factories Act of 1937 that deal with points under the jurisdiction of (*a*) the Labour Department; (*b*) the Health Department; (*c*) the Welfare Department.

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1. How should Labour Turnover be measured?

What are its chief causes, indicating those in which the foreman is concerned?

2. What are Job Analysis and Specification?

How does the foreman help in their preparation?

3. Describe the routine personal records used by the Employment Department in the engagement and dismissal of labour.

4. The Employment Department is also concerned with group records of employees. What are these? Explain how they are drawn up and their utility.

5. Discuss the responsibility of the foreman for the psychological aspect of working conditions.

6. Describe the use of a rating chart for (*a*) interviews; (*b*) labour audit. Illustrate in each case.

7. Assume you are a foreman in charge of a shop where work is neither completely automatic nor skilled.

What points ought you to observe in selecting and dealing with operatives with a view to avoid boredom?

8. Under what conditions can a workman obtain compensation for an injury through accident? What is his procedure for making a claim?

9. In what ways can a foreman assist the Employment Manager in his duty of ensuring an efficient and economical investment in man-power?

10. Suggest a training scheme for engineering apprentices to extend from 15 to 19 years old.

Principles of Production and Planning

1. Explain the importance of Production Control, and indicate the main considerations to be borne in mind when organising production.

2. Indicate the features to be considered in preparing a Manufacturing Programme, and state the advantages of applying a Production Budget to initiate manufacture.

3. State reasons for the necessity of close relationship between the Production Department and:

(*a*) Design and Engineering Department; (*b*) Purchasing Department; (*c*) Stores; (*d*) Manufacturing Shops; (*e*) Assembly Department.

4. List the features coming under the Function of Design, and explain the advantages of designing so as to facilitate production.
5. Describe the uses of Production Planning and Progress Control, giving methods used to apply these functions in practice. Indicate why the functions are necessary.
6. What are the points needing consideration in the selection and lay-out of plant and equipment?
7. Indicate the various forms of mechanical handling, stating the advantages of each, with its applications.
8. Explain the need for efficient organisation in the Stores, giving illustrations.

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1. What is "functional organisation"? Indicate its advantages and disadvantages.
2. Indicate the flow of instructions from receipt of a customer's order to despatch of the goods.
3. Show a typical organisation chart of a manufacturing firm, and indicate the relationship of the production shops to other departments.
4. Distinguish between line and group layout of machines, and mention the advantages of each.
5. Discuss the importance of design of (*a*) engineering products; (*b*) non-engineering products.
6. How can the drawing office keep track of the prints in the shops?
7. Describe how work is progressed to be done on time in your own shop, or in some shop known to you.
8. What is a Gantt chart? Illustrate your answer.
9. Describe a system of Stores Control.
10. "A conveyor is the most efficient form of internal transport." Is this statement strictly true? When might it be preferable to use power or hand trucks?
11. Assuming an article is going to be made which will require new tools, how should you plan out the manufacture of the tools to arrive as they are required in the production shops?
12. What is work planning? Refer in your answer to the three constituents of a job—materials, methods, times.

Principles of Remuneration and Estimating

1. Write brief notes on the various Wage Theories that have been put forward from time to time. Give a reasonable explanation of current wage levels.
2. "Efficient output can be obtained at such a price that efficient cost is made impossible." Discuss this statement, and enunciate the main considerations which should guide you in introducing a system of payment by results.

3. It is estimated that a certain job can be done in 60 hours. The rate is 1*s*. per hour, and bonus is to be provided at $33\frac{1}{3}\%$ on base rate. Show by means of diagrams the wages earned under (*a*) the Halsey and (*b*) Halsey-Weir premium systems, for different periods of time taken.

4. "An age of specialisation has succeeded an age of generalisation." Apply this statement to the control of rate-fixing.

5. What are the means by which a satisfactory basis for job rates can be arrived at? What influence will different classes of work have on the methods to be used?

6. Discuss the contention that Profit Sharing is an improvement upon payment by results.

7. What main factors should be considered in general production estimating?

8. Consider the advisability of using Costs as a basis for payment by results to supervisory staff.

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1. How are the theoretical maximum and minimum levels of wages fixed for any given class of labour?

2. A machine operator's time rate is 1*s*. 8*d*. per hour and his output five pieces per hour. Overheads are taken as 125% on direct wages. The material for each piece costs 8*d*. Find the factory cost.

The man is put on piece rate at 3*d*. per piece and makes eight pieces per hour. Find his actual earnings and the new factory cost per piece.

3. What is the Bedaux System of wage payment? Discuss the value of this system.

4. If time studies are to be introduced in a machine shop, what would be the procedure (*a*) preliminary to their introduction; (*b*) in making an actual study?

5. What qualifications are required in a man who is to be appointed rate-fixer in an engineering shop?

6. What are the alternative methods of rate-fixing? Which appears to be the most scientific? Explain when the other methods might be used.

7. In estimating material costs what information is necessary to an estimator to enable him to quote accurate and reliable figures?

8. Overheads are said to be the most difficult constituent of total cost to estimate accurately. State how the difficulty arises and what method of estimating overheads is to be preferred.

9. Draw up an estimate form making provision for collecting the anticipated costs of either (*a*) general engineering jobs or (*b*) bakelite moulding jobs.

10. State the steps necessary to be taken in connection with a customer's enquiry up to the stage when the estimate is to be made.

Elements of Costing

1. Discuss the main advantages to be obtained from a costing system. What precautions are advisable in installing such a system?

2. Enumerate the various ways in which issues of materials from Factory Stores may be priced. Discuss the relative merits and demerits of each method.

3. Why is it considered necessary to departmentalise overhead expenses? What constitutes a "department" for this purpose? Distinguish between production and "service" departments.

4. A manufacturing business is divided into three manufacturing departments X, Y, and Z. The manufacturing expenditure is divided as follows:—

	X	Y	Z
Direct Labour . .	£20,000	8,000	14,000
Works Overhead . .	£10,000	16,000	14,000

Assuming that Direct Wages are a fairly accurate measure for the distribution of works overhead, what objection could be taken in each case to recovering such overhead expenses at a flat rate, say of 100%, on wages?

5. What is meant by "operating costs"? Show clearly the difference between the "commercial" and the "absolute" ton-mile as used in a transport organisation.

6. What is meant by a Perpetual Inventory System? How does it operate? What are the advantages claimed for it?

7. What considerations would justify the acceptance of an order at less than cost? (Hypothetical figures may be taken to illustrate and justify any arguments advanced.)

8. What are the purposes of cost control accounts? Explain the principle upon which a control account is constructed.

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1. What are the elements of cost? Why is it important that a firm should know them correctly?

2. How is labour cost recorded, both direct and indirect? Illustrate your answer.

3. How is the cost of materials controlled?

4. What are "oncosts"? Explain the effect on them of a fall in output of the works.

5. How are oncosts allocated to the production centre where they arise?

6. What is the machine-hour rate method of allocating overheads to the product itself? Show a cost lay-out based on machine-hour rate.

7. Define depreciation. Give an example of a recommended method of depreciating the values of a plant or machine, and mention its advantages.

8. What are "Standard Costs"? Why has standard costing been called "control by recording differences"?

9. What are the principal forms in use for recording costs, from the issue of a factory order?

10. Explain the value of costing to a foreman. What information should be given him?

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